

CAMBRIDGE INTERNATIONAL AS & A LEVEL • PHYSICS 9702

Topical Questions

Unit 1: Unit and Measurement

Past Papers 2021 – 2025

MARK SCHEME 24 Questions

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Question 1 — Mark Scheme

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Question	Answer	Marks
1(a)	mass / volume	B1
1(b)(i)	(vernier/digital) calipers	B1
1(b)(ii)	percentage uncertainty = $(0.0004 / 0.0420) \times 100$ = 1%	A1
1(c)(i)	$\text{kg m}^{-3} = \text{kg} \times \text{m}^n / \text{m}$ or $\text{kg m}^{-3} = \text{kg} \times \text{m}^n \times \text{m}^{-1}$	M1
	$-3 = n - 1$ and (so) $n = -2$	A1
1(c)(ii)	$(\Delta\rho / \rho) = (\Delta M / M) + 2(\Delta r / r) + (\Delta L / L)$	C1
	percentage uncertainty = $[(0.001 / 1.072) + 2 \times (0.0004 / 0.0420) + (0.0001 / 0.1242)] (\times 100)$	C1
	= $0.09\% + 2 \times 0.95\% + 0.08\%$	A1
	= 2%	
1(c)(iii)	$\rho = (1.072 \times 0.0420^{-2}) / (2.094 \times 0.1242)$ = 2337 (kg m^{-3})	C1
	$\Delta\rho = 0.021 \times 2337$ = 49 (kg m^{-3})	C1
	$\rho = (2340 \pm 50) \text{ kg m}^{-3}$	A1

Question 2 — Mark Scheme

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Question	Answer	Marks
1(a)	10^{12}	B1
	pico (p)	B1
1(b)	ampere and metre both underlined (and no other units underlined)	B1
1(c)(i)	percentage uncertainty = $3.5 + (3.0 \times 2) + 2.5 + 2.0$	C1
	= 14%	A1
1(c)(ii)	absolute uncertainty = $4.1 \times 10^{-7} \times 14 / 100$ = $6 \times 10^{-8} \Omega \text{ m}$	A1

Question 3 — Mark Scheme

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Question	Answer	Mark
1(a)	mass / volume	B1
1(b)(i)	absolute uncertainty = $4.0 \times (5 / 100)$ = $(\pm) 0.2 \text{ cm}$	B1
1(b)(ii)	percentage uncertainty = $2 + 4 + (5 \times 2)$	C1
	= $(\pm) 16\%$	A1
1(c)	$p = F / A$ or $p = W / A$	C1
	$p = (19.5 \times 10^{-3} \times 9.81) / (4.0 \times 10^{-2})^2$	C1
	= 120 Pa	A1

Question 4 — Mark Scheme

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Question	Answer	Marks
1(a)(i)	two correct scalar quantities e.g. time, mass, distance, temperature	B1
	two correct vector quantities e.g. force, acceleration, velocity, displacement	B1
1(a)(ii)	magnitude	B1
	unit	B1
1(b)(i)	north component of velocity = 11 m s^{-1}	A1
	east component of velocity = 7.5 m s^{-1}	A1
1(b)(ii)	velocity = $7.5 - 2.7$ $= 4.8 \text{ m s}^{-1}$	A1
1(b)(iii)	velocity = $\sqrt{11^2 + 4.8^2}$	C1
	$= 12 \text{ m s}^{-1}$	A1
1(b)(iv)	angle = $\tan^{-1} (4.8 / 11)$	C1
	$= 24^\circ$	A1

Question 5 — Mark Scheme

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Question	Answer	Marks
1(a)		C1
	any two joined correctly	
	all four joined correctly	A1
1(b)(i)	the measurements have a small range	B1
1(b)(ii)	(average of the) measurements not close to the true value	B1
1(c)(i)	percentage uncertainty = $(3 + 5 + 4) / 2$	C1
	= 6%	A1
1(c)(ii)	absolute uncertainty = $(6 / 100) \times 15.0$	A1
	= 0.9 ms^{-1}	

Question 6 — Mark Scheme

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Question	Answer	Marks
1(a)	force $\times$ displacement in the direction of the force	B1
1(b)	$P = Fs / t$ $= (\text{kg m s}^{-2} \times \text{m}) / \text{s}$	C1
	$= \text{kg m}^2 \text{s}^{-3}$	A1
1(c)(i)	$84 \times 10^3 = v^3 \times 0.56$	C1
	$v = 53 \text{ m s}^{-1}$	A1
1(c)(ii)	percentage uncertainty = $(5\% + 7\%) / 3$ (= 4%) or fractional uncertainty = $(0.05 + 0.07) / 3$ (= 0.04)	C1
	absolute uncertainty = 0.04×53 $= (\pm) 2 \text{ m s}^{-1}$	A1

Question 7 — Mark Scheme

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Question	Answer	Marks
1(a)	(SI base unit of α =) $\text{m}^3 \text{s}^{-1} \times \text{m} / \text{m}^4 = \text{s}^{-1}$	A1
1(b)	(percentage uncertainty =) $3 + 4 + 2 \times 4 = 15$ (%)	A1
1(c)	$\alpha = QL / r^4$ $= 2.72 \times 10^{-8} \times 2.5 \times 10^{-2} / (7.1 \times 10^{-5})^4$ $= 2.7 \times 10^7$	C1
	absolute uncertainty = $0.15 \times [2.7 \times 10^7]$ $= 0.4 \times 10^7$	C1
	$\alpha = (2.7 \pm 0.4) \times 10^7 \text{s}^{-1}$	A1

Question 8 — Mark Scheme

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Question	Answer	Marks
1(a)	only ampere and kilogram underlined	B1
1(b)(i)	percentage uncertainty = $2.1 + 0.6 + (1.5 \times 2)$	C1
	= 5.7%	A1
1(b)(ii)	absolute uncertainty = $(5.7 / 100) \times 8.245 \times 10^9$ (= 4.7×10^8 Pa or 0.47×10^9 Pa)	C1
	$E = (8.2 \pm 0.5) \times 10^9$ Pa	A1

Question 9 — Mark Scheme

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Question	Answer	Marks
1(a)	$\rho = m / V$	C1
	$V = (4 / 3) \times \pi \times r^3$ $= (4 / 3) \times \pi \times (3.42 / 2)^3$ $(= 20.9 \text{ cm}^3)$	C1
	$\rho = 67 / 20.9$ $= 3.2 \text{ g cm}^{-3}$	A1
1(b)	$\% \rho = \%m + 3 \times \%d$ $= [(2 / 67) \times 100] + [3 \times (0.02 / 3.42) \times 100]$	C1
	$= 3.0\% + 3 \times 0.58\%$ $= 4.7\% \text{ or } 5\%$	A1

Question 10 — Mark Scheme

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Question	Answer	Mark
1(a)	scalar and vector have magnitude	B1
	vector has direction (and scalar does not have direction)	B1
1(b)(i)	$r = [(3 \times 28) / 4\pi]^{1/3}$ $= 1.9 \text{ cm}$	A1
1(b)(ii)	percentage uncertainty in $V = (0.5 / 28) \times 100$ $(= 1.79\%)$	C1
	percentage uncertainty in $r = 1.79 / 3$ $= 0.6\%$	A1

Question 11 — Mark Scheme

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Question	Answer	Mark
1(a)	scalar and vector have magnitude	B1
	vector has direction (and scalar does not have direction)	B1
1(b)(i)	$r = [(3 \times 28) / 4\pi]^{1/3}$ $= 1.9 \text{ cm}$	A1
1(b)(ii)	percentage uncertainty in $V = (0.5 / 28) \times 100$ $(= 1.79\%)$	C1
	percentage uncertainty in $r = 1.79 / 3$ $= 0.6\%$	A1

Question 12 — Mark Scheme

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Question	Answer	Marks
1(a)	charge and power only ticked	B1
1(b)(i)	$\%D = 0.4\%$ and $\%L = 0.6\%$	A1
1(b)(ii)	$\rho = (4 \times 0.247) / [\pi \times (26.2 \times 10^{-3})^2 \times 0.162]$	C1
	$\rho = 2.83 \times 10^3 \text{ kg m}^{-3}$	A1
1(b)(iii)	percentage uncertainty $= 0.4 + (2 \times 0.4) + 0.6$	C1
	$= 1.8\%$	A1

Question 13 — Mark Scheme

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Question	Answer	Marks
1(a)(i)	work done per unit time	B1
1(a)(ii)	$(P = W / t \text{ gives})$ units: $\text{kg m}^2 \text{s}^{-2} / \text{s} = \text{kg m}^2 \text{s}^{-3}$	B1
1(b)	$(I = P / A \text{ so})$ units of I : $\text{kg m}^2 \text{s}^{-3} / \text{m}^2$ or kg s^{-3}	C1
	units of f : s^{-1} and units of A : m and units of v : m s^{-1}	C1
	units of k : $\text{kg s}^{-3} / [(\text{s}^{-1})^2 \text{m}^2 \text{m s}^{-1}]$ $= \text{kg m}^{-3}$	A1

Question 14 — Mark Scheme

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Question	Answer	Marks
1(a)(i)	force / area (normal to the force)	B1
1(a)(ii)	$(p = F / A \text{ so units are})$ $\text{kg m s}^{-2} / \text{m}^2 = \text{kg m}^{-1} \text{s}^{-2}$	A1
1(b)	unit of R : m and unit of t : s and unit of L : m	C1
	unit of ρ : kg m^{-3} or $\rho = m / V$	C1
	base units of k : $(\text{kg m}^{-1} \text{s}^{-2} \times \text{m}^4 \times \text{kg m}^{-3} \times \text{s}) / (\text{kg} \times \text{m}) = \text{kg m}^{-1} \text{s}^{-1}$	A1
1(c)	R contributes $4 \times 2\%$ or 8% (and L contributes 2%) so R contributes more (to the percentage uncertainty in k)	B1

Question 15 — Mark Scheme

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Question	Answer	Marks
1(a)	only ampere and kelvin underlined	B1
1(b)	initial speed / velocity is zero	B1
	(non-zero magnitude of) acceleration is constant / uniform (and in a straight line)	B1
1(c)(i)	$a = 2.75^2 / (2 \times 3.89)$ $= 0.97 \text{ m s}^{-2}$	A1
1(c)(ii)	percentage uncertainty = $(2 \times 0.8) + 0.5$	C1
	$= 2.1\%$	A1
1(c)(iii)	absolute uncertainty = $(2.1 / 100) \times 0.97$ $= 0.02 \text{ m s}^{-2}$	A1

Question 16 — Mark Scheme

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Question	Answer	Marks
1(a)	mass per unit volume	B1
1(b)(i)	density = $0.243 / (0.0541 \times 0.1109 \times 0.0162)$	C1
	= 2500 kg m^{-3}	A1
1(b)(ii)	$(0.001 / 0.243)$ or $(0.01 / 5.41)$ or $(0.01 / 11.09)$ or $(0.01 / 1.62)$	C1
	$(\Delta\rho / \rho) = (\Delta m / m) + (\Delta x / x) + (\Delta y / y) + (\Delta z / z)$ $= (0.001 / 0.243) + (0.01 / 5.41) + (0.01 / 11.09) + (0.01 / 1.62)$ $(= 0.013)$	C1
	percentage uncertainty in $\rho = 0.013 \times 100$ $= 1.3\%$ (allow 1 s.f. answer of 1%)	A1
1(c)	zero error (on calipers / balance) or incorrect calibration (of calipers / balance)	B1

Question 17 — Mark Scheme

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Question	Answer	Marks
1(a)	a quantity with magnitude and direction	B1
1(b)(i)	SI base units of D : kg m s^{-2}	C1
	SI base units of r : m and v : m s^{-1}	C1
	base units of η : $\text{kg m s}^{-2} / (\text{m} \times \text{m s}^{-1})$ $= \text{kg m}^{-1} \text{s}^{-1}$	A1
1(b)(ii)	$W = U + D$	A1
1(b)(iii)	$U = 830 \times 9.81 \times 4.6 \times (10^{-2})^3$ (= 0.037 N)	C1
	$W = 0.037 + 0.32$ $= 0.36 \text{ N}$	A1

Question 18 — Mark Scheme

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Question	Answer	Marks
1(a)	units of F_D : kg m s^{-2}	M1
	units of ρ : kg m^{-3} and units of A : m^2 and units of v : m s^{-1} or units of v^2 : $\text{m}^2 \text{s}^{-2}$	M1
	$\text{kg m s}^{-2} = C \text{ kg m s}^{-2}$ and comment '(so) C has no units' / unit terms cancelled or $C = \text{kg m s}^{-2} / (\text{kg m}^{-3} \text{ m}^2 \text{ m}^2 \text{s}^{-2})$ and comment '(so) C has no units' / unit terms cancelled	A1

Question 19 — Mark Scheme

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Question	Answer	Marks
1(a)	charge underlined (and no others)	B1
1(b)(i)	$I = P / A$	C1
	$= 750 / (1300 \times 10^{-3})^2$	C1
	$= 440 \text{ W m}^{-2}$	A1
1(b)(ii)	percentage uncertainty $= 3 + 2 \times (5 / 1300) \times 100$	C1
	$= 3 + 2 \times 0.38$	A1
	$= (\pm) 4\%$	
1(b)(iii)	efficiency = useful output power / total input power $= (160 / 750) \times 100$ $= 21\%$	A1
1(b)(iv)	area (of the new panel) is less	B1
	input power (of the new panel) is less (than the input power of the original panel) (as intensity is constant)	B1
	(useful power output is unchanged so) efficiency is greater (than the original panel)	B1

Question 20 — Mark Scheme

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Question	Answer	Marks
1(a)	units of F : kg m s^{-2}	C1
	units of r : m and units of v : m s^{-1}	A1
	units of η : $\text{kg m s}^{-2} / (\text{m} \times \text{m s}^{-1}) = \text{kg m}^{-1} \text{s}^{-1}$	
1(b)	viscosity = $0.096 / (6 \times \pi \times 0.03 \times 2.0)$	C1
	= $0.085 \text{ kg m}^{-1} \text{s}^{-1}$	A1

Question 21 — Mark Scheme

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Question	Answer	Marks
1(a)	current and mass only ticked	A1
1(b)	(power =) work (done) / time	C1
	units of power = J s^{-1} = $\text{kg m}^2 \text{s}^{-2} / \text{s}$ = $\text{kg m}^2 \text{s}^{-3}$	A1
1(c)	power = intensity $\times$ area	C1
	= $950 \times 2.2 \times 10^{-4}$	C1
	= 0.21 W	A1

Question 22 — Mark Scheme

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Question	Answer	Marks
1(a)	air temperature: K and air pressure: $\text{kg m}^{-1} \text{s}^{-2}$	B1
	scalar only ticked for both air temperature and air pressure	B1
1(b)(i)	$\text{upthrust} = 1.1 \times 9.81 \times (4\pi \times 0.90^3 / 3)$	C1
	$= 33 \text{ N}$	A1
1(b)(ii)	(due to difference in height / depth there is a) difference in pressure between top and bottom (of balloon)	B1
	(due to pressure difference, upwards) force on bottom of balloon is greater (than downwards force on top of balloon, so resultant force is upwards)	B1
1(b)(iii)	$(\Sigma)F = 33 - 19$ $(= 14 \text{ N})$	C1
	$m = 19 / 9.81$ $(= 1.94 \text{ kg})$	C1
	$a = (33 - 19) / (19 / 9.81)$ $= 7.2 \text{ m s}^{-2}$	A1
1(c)	$5 + 3 + (2 \times 4)$ $(= 16\%)$	C1
	absolute uncertainty in $c = 1.8 \times 0.16$ $= (\pm) 0.3$	A1

Question 23 — Mark Scheme

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Question	Answer	Marks
1(a)	acceleration and displacement identified as vectors (and no others)	B1
	speed, temperature and gravitational potential energy identified as scalars (and no others)	B1

Question 24 — Mark Scheme

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Question	Answer	Marks
1(a)	how close the (measured) value is to the true value (of the quantity)	A1
1(b)(i)	$(\rho =) m / V$	C1
	$= 31.3 \times 10^{-3} / (1.53 \times 10^{-2})^3 = 8.7 \times 10^3 \text{ (kg m}^{-3}\text{)}$	A1
1(b)(ii)	(0.5 / 31.3) or (0.01 / 1.53) % uncertainty = $(0.016 \times 100) + 3 \times (0.0065 \times 100)$	C1
	= 4%	A1
1(b)(iii)	The ranges (of the densities of A and B) overlap or the (calculated) density of A is within the range of the density of B or the difference in densities is within the uncertainty (of B)	M1
	(so) they could be the same	A1

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