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This document consists of **10** printed pages.

Question	Answer	Marks
1(a)(i)	Distance = area under graph OR $0.5 \times 20 \times 13$	**C1**
	130 m	**A1**
1(a)(ii)	$(a =) (v - u) / t$ OR $(a =) v / t$ OR $13 / 20$	**C1**
	$0.65 \, \text{m} / \text{s}^2$	**A1**
1(a)(iii)	$(F =) ma$ OR 1200×0.65	**C1**
	= 780 N	**A1**
1(b)	Acceleration decreases OR rate of increase of speed decreases OR speed increases at a lower rate	**B1**

Question	Answer	Marks
2(a)	Extension of a spring is (directly) proportional to load / force / weight OR $F = ke$ where e is extension	**B1**
2(b)(i)	<u>Straight</u> line drawn from origin to (64 mm, 120 N)	**B1**
2(b)(ii)	$F = ke$ in any form OR $120 / 64$ OR $120 / 6.4$ OR $120 / 0.064$	**C1**
	c.a.o. 1.9 N / mm OR 19 N / cm OR 1900 N / m	**A1**
2(c)	Above 120 N / at 140 N, the spring does not obey Hooke's law OR the extension is not proportional to the load / weight / force	**B1**
	The elastic limit / limit of proportionality of the spring has been exceeded	**B1**

Question	Answer	Marks
3(a)	(Measure of) quantity / amount of matter OR (property) that resists change in motion / speed / momentum OR measure of a body's inertia	B1
3(b)(i)	$d = m / V$ OR in words OR $0.44 / 0.080^3$ OR $0.44 / 5.12 \times 10^{-4}$ OR $440 / 8^3$ OR $440 / 512$ OR $0.44 / 8^3$ OR $0.44 / 512$	C1
	$0.86\ \text{g} / \text{cm}^3$ OR $860\ \text{kg} / \text{m}^3$ OR $8.6 \times 10^{-4}\ \text{kg} / \text{cm}^3$	A1
3(b)(ii)	Sinks OR does not float AND (cube) denser (than oil)	B1
3(c)(i)	$W = mg$ OR $(g =)\ W / m$ OR $0.70 / 0.44$	C1
	$1.6\ \text{N} / \text{kg}$	A1
3(c)(ii)	$(P =)\ hdg$ OR $0.030 \times 850 \times 1.6$	C1
	41 Pa	A1

Question	Answer	Marks
4(a)	Atoms collide with wall (and rebound) OR atoms rebound from wall	B1
	(Atoms) undergo change of momentum	C1
	Force on wall = (total) rate of change of momentum (of atoms) OR = change of momentum (of atoms) per second OR = change of momentum (of atoms) / time	A1
4(b)(i)	Fewer atoms per unit volume OR density of gas less	B1
	Rate of collision (with walls of balloon) decreases OR Fewer collisions per unit area	B1
4(b)(ii)	PV = constant OR $P_1 V_2 = P_2 V_2$ OR $(P_2 =)\ P_1 V_1 / V_2$ OR $1.0 \times 10^5 \times 9.6 / 12$	C1
	$8.0 \times 10^4\ \text{Pa}$	A1

Question	Answer	Marks
5(a)	Tick 2nd box only	**B1**
5(b)(i)	At least 3 parallel wavefronts in shallow water sloping upwards from left to right	**B1**
	Wavefronts in shallow water meet wavefronts in deep water	**B1**
5(b)(ii)	Indication that frequency is same in deep and shallow water	**C1**
	In deep water $v = f\lambda$ in any form OR $(f =) v/\lambda$ OR $80/1.4$	**C1**
	= 57.1 (Hz)	**C1**
	Wavelength in shallow water = v/f OR $60/57.1 = 1.05$ cm	**A1**
	OR	
	speed in deep water / speed in shallow water = $0.80/0.60$	**(C1)**
	= 1.33	**(C1)**
	(f is constant so) λ in deep water / λ in shallow water = 1.33	**(C1)**
	λ in shallow water = $1.4/1.33 = 1.05$ cm	**(A1)**

Question	Answer	Marks
6(a)	1500 m / s liquid 5000 m / s solid 300 m / s gas	**B2**
6(b)(i)	X and Y marked at centres of any two rarefactions	**B1**
6(b)(ii)	Area of low pressure or low density (of atoms) or where atoms / molecules far apart	**B1**
6(c)	$v = = d / t$ or $2\,d / t$ in any form	**C1**
	$d = v\,t / 2$ OR $3.0 \times 10^8 \times 2.56 / 2$	**C1**
	3.84×10^8 m OR 3.84×10^5 km	**A1**

Question	Answer	Marks
7(a)	One ray with correct path through lens	**B1**
	Another ray with correct path through lens Rays intersect to right of F and below axis, inverted image	**B1**
	drawn <u>and</u> labelled I	**B1**
7(b)	enlarged, upright and virtual <u>only</u> underlined or ringed	**B2**
	Two of above descriptions underlined	**B1**
7(c)	On entering prism: green ray deflection more than red ray and above normal	**B1**
	On leaving prism: diverging downwards from red ray and not along surface of prism	**B1**

Question		Answer	Marks
8		Hydroelectric	
	8(a)	Hydroelectric named OR water from behind dam	**B1**
		K.E. of (falling) water used / P.E. of stored water	**B1**
		Turbine / waterwheel / paddle wheel operated	**B1**
		(Turbine) turns / drives a generator (that produces electricity)	**B1**
	8(b)	Rain (fills lakes in high places)	**B1**
		Cause of rain is the Sun, so renewable	**B1**
	8(c)	Sun evaporates water from sea etc. to fall (later) as rain	**B1**
		Sun is the source of energy.	**B1**
8		Tidal flow	
	8(a)	Tides / tidal flow named	**B1**
		K.E. of water used	**B1**
		Turbine / waterwheel / paddle wheel operated	**B1**
		(Turbine) turns / drives a generator (that produces electricity)	**B1**
	8(b)	Moon (and Sun) causes tides	**B1**
		Moon (and Sun) permanently in place, so renewable	**B1**
	8(c)	Attraction due to Moon's (and Sun's) gravity causes tides	**B1**
		Sun is a source of (part of) the energy OR Sun is not the primary source of energy	**B1**

Question	Answer	Marks
8 Waves		
8(a)	Waves on surface of sea	**B1**
	K.E. of water used to oscillate a floating mechanism	**B1**
	Turbine / waterwheel / paddle wheel operated	**B1**
	(Turbine) turns / drives a generator (that produces electricity)	**B1**
8(b)	Wind causes waves	**B1**
	Sun causes wind, so renewable	**B1**
8(c)	Winds are air currents caused by thermal energy / heat from the Sun	**B1**
	Sun is the source of energy	**B1**

Question	Answer	Marks
9(a)(i)	$(3 \times 1.5 =)$ 4.5 V	**B1**
9(a)(ii)	$1 / R = 1 / R_1 + 1 / R_2$ OR $R = 1 / (1 / R_1 + 1 / R_2)$ OR $(R =)\ R_1 R_2 / (R_1 + R_2)$	**C1**
	Correct substitution of 3 and 6	**C1**
	$(R =)$ 2.0 Ω	**A1**
9(a)(iii)	$V = IR$ in any form OR $(I =)\ V / R$ OR $4.5 / 3$	**C1**
	1.5 A	**A1**
	OR	
	$I_{total} = 4.5 / 2 = 2.25$ A	**(C1)**
	For 3 Ω, $I = 2.25 \times 6 / 9 = 1.5$ A	**(A1)**
9(b)(i)	Connect ammeter (in wire) from A to B OR from H to G	**B1**
9(b)(ii)	Connect voltmeter (terminals) to A and H OR B and G OR C and D OR E and F	**B1**

Question	Answer	Marks
10(a)(i)		**B1**
10(a)(ii)	To allow flow (of current) in one direction	**B1**
10(b)(i)	Wire from B to + or – terminal of battery and wire from A to other terminal of battery	**B1**
	Diode to allow current in at + terminal or out at – terminal	**B1**
10(b)(ii)	Alternating current in coil Y sets up alternating magnetic field OR causes change in magnetic flux	**B1**
	Alternating field / change in flux cuts coil X OR Alternating field links with coil X	**B1**
	(Alternating) voltage / current is induced in coil X OR (Alternating) voltage / current is produced in coil X by electromagnetic induction	**B1**

Question	Answer	Marks
11(a)(i)	An electron	**M1**
	In / from / by the nucleus	**A1**
11(a)(ii)	Proton numbers balance on left and right sides of equation	**B1**
	Nucleons numbers balance on left and right sides of equation	**B1**
	$_{-1}^{0}\beta$	**B1**
11(b)	Time for activity / count rate / number of nuclei / number of atoms to halve	**B1**
11(c)(i)	α-particles would be stopped / absorbed by <u>the plastic</u> / <u>bottle</u>	**B1**
11(c)(ii)	γ-rays would not be absorbed by the liquid / bottle OR reading not reduced (in passing through liquid / bottle) OR very penetrative so no change in detector reading	**B1**