Question	Answer	Marks	AO Element	Notes	Guidance
1(a)	(A = 44 × 20 =) 880 (m^2) (1) V = A × depth in any form **OR** (d =) V / A (1) (d = 264 / 880 =) 0.30 m (1)	**3**			
1(b)	ρ = m / V in any form **OR** (ρ =) m / V (1) (ρ = 2.7 × 10^5 / 264 =) 1020 kg / m^3 (1)	**2**			
1(c)	p = ρgh in any form **OR** (p =) ρgh (1) (p = 1020 × 10 × 0.3 =) 3 100 Pa (1)	**2**			
2(a)	66.4(0) (s)	**1**			
2(b)	3.3(2) (s) (2) OR ALLOW 66.4 ÷ 20 (1)	**2**			

Question	Answer	Marks	AO Element	Notes	Guidance
3	any **four** from: measuring cylinder partially filled with water / displacement can filled with water volume of water recorded / empty measuring cylinder under spout coin(s) in water / water covers all coin(s) new volume noted / displaced water collected in measuring cylinder (average) volume of a coin = increase in volume **OR** increase in volume ÷ number of coins	**4**			
4	83.37 (s) seen (1) 83.37 ÷ 50 (1) 1.67 (s) (1)	**3**			
5	start stopwatch as LED lights owtte (1) count large number of flashes i.e. ≥ 10 (1) stop stopwatch on nth lighting of LED **AND** n≥ 1 (1) divide time on stopwatch by n (1)	**4**			
6(a)	(678 – 318 =) 360 (g)	**1**			

Question	Answer	Marks	AO Element	Notes	Guidance
6(b)(i)	160 (cm^3)	**1**			
6(b)(ii)	400 (cm^3)	**1**			
6(b)(iii)	D = m / v in any form (1) 360 ÷ 400 (1) 0.9 (g/cm^3) (1)	**3**			
7(a)	2.77 – 2.22 **OR** 0.55 (1) 1.1(0) (s) (1)	**2**			
7(b)	any **four** from: (idea of) use of fiducial mark start watch as pendulum passes fiducial mark **OR** when pendulum released count large number (must be >=10) of swings stop watch as pendulum passes marker **OR** starting point divide total time by the number of swings timing to centre of swing	**4**			
8(a)	longitudinal	**1**			

Question	Answer	Marks	AO Element	Notes	Guidance
8(b)	sound wave	**1**			
8(c)	85–99 (cm)	**1**			
9(a)	mass in kg **AND** height in m (1) area in m^2 (1)	**2**			
9(b)(i)	W = m × g (1) 4000 × 10 (1) 40 000 (N) (1)	**3**			
9(b)(ii)	P = F ÷ A in any recognisable form (1) (area =) 0.125 × 4 = 0.50 (m^2) (1) b(i) ÷ 5000 **OR** 40 000 ÷ 0.500 (1) 80 000 N / m^2 **OR** 80 000 Pa (1)	**4**			
10(a)(i)	tape measure	**1**			
10(a)(ii)	reflection (of sound)	**1**			

Question	Answer	Marks	AO Element	Notes	Guidance
10(b)	time for sound to travel to wall and back = 1.0 s (1) 340 m in 1.0 s (1) (speed=) 340 (1) m / s (1)	**4**			
11	area under line **OR** three areas indicated **OR** (dist=) (average) speed × time **OR** 1/2 (b + h) × L (1) $\frac{1}{2}$ × 3.5 × 4.0 **OR** 7 (m) seen **OR** 6 × 3.5 **OR** 21 (m) (1) 6 × 3.5 **OR** 21 (m) **AND** {$\frac{1}{2}$ × 3.5 × 4.0 **OR** 7 (m)} **OR** 14 (m) (1) (21 + 14 =) 35 (m) (1)	**4**			
12(a)	43.9 – 19.7 or 24.2 (cm)	**1**			

Question	Answer	Marks	AO Element	Notes	Guidance
12(b)	any **two** from: measure the extension for different (number of 1.0 N) loads repeat each reading (as each (1.0 N) load is removed) **AND** calculate average (extension for each load) (take reading from ruler with) eye level with pin	**2**			
13(a)	30 × 20 × 5 or length × width × height or cross-sectional area × length	**1**			
13(b)	D = M / V in any acceptable form (1) 2400 ÷ 3000 (1) 0.80 (g / cm^3) or 0.8 (g / cm^3) (1)	**3**			
14	C - 1.71 s	**1**			
15	B - 3.7 cm / s	**1**			
16(a)	rule(r) (stop) watch/clock	**2**			

Question	Answer	Marks	AO Element	Notes	Guidance
16(b)(i)	x-axis labelled time/t with minutes y-axis clearly labelled depth/distance/height with mm/cm/m	**2**			
16(b)(ii)	line drawn from the origin single straight diagonal line	**2**			
16(c)	1000 mm = 1 m **OR** 2.5 ÷ 1000 0.0025 (m) **OR** $2.5 \cdot 10^{-3}$	**2**			
17(a)	any **two** from: use a ruler with mm (scale) ruler close(r) to book/no space between book and ruler have zero on ruler at one end of book take reading with eye in line with end of book owtte	**2**			

Question	Answer	Marks	AO Element	Notes	Guidance
17(b)	use large number of pages i.e. more than 50 measure (total) thickness (with ruler) divide (total) thickness by number of pages	**3**			
17(c)	convert g to kg or 400 ÷ 1000 Weight = mass · gravitational field strength in any form (weight =) 4.0 (unit) N or newtons	**4**			
18(a)	flexible rule/tape measure/measuring tape	**1**			
18(b)(i)	58.75 (s)	**1**			
18(b)(ii)	speed = distance ÷ time in any form 0.85 (m/s)	**2**			
18(b)(iii)	7.12 (s)	**1**			

Question	Answer	Marks	AO Element	Notes	Guidance
19	any **two** from: - wire not starting at 0 cm - wire not straight - wire away from / not close to rule	**B2**			
20	volume = length × cross-sectional area words, symbols or numbers	**C1**			
	8.0	**A1**			accept 8 (cm^3)
21(a)	time of burning: 2 hours 15 minutes	**B1**			
	2.25 hours	**B1**			accept $2\frac{1}{4}$ hours
21(b)	(speed =) distance÷time in any form: symbols, words, numbers	**C1**			ecf from **(a)**

Question	Answer	Marks	AO Element	Notes	Guidance
	0.8(0) cm / hour	**A1**			ecf from **(a)**
21(c)	correct deduction from candidate's **(b)**	**B1**			
	correct reasoning from candidate's **(b)** e.g. 24 cm candle would burn for 30 h **OR** 19.2 cm will burn in 24 h	**B1**			
22	rule alongside spring	**B1**			
	set zero at one end and read scale at other end **OR** take scale reading at each end and subtract	**B1**			
	extra valid detail, e.g. rule close to and parallel with spring, use of marker/setsquare, eye level with reading etc.	**B1**			

Question	Answer	Marks	AO Element	Notes	Guidance
23	reaction time owtte **OR** delay in hearing sound	**B1**			
24(a)	measuring cylinder / graduated cylinder	**B1**			
24(b)	balance	**B1**			accept spring balance accept (weighing) scales
24(c)	find mass of empty cylinder	**B1**			
	find mass of cylinder + liquid	**B1**			
	subtract values	**B1**			**NOT** if stated the wrong way round accept valid alternative methods
25	metre rule, tape measure, (surveyor's) laser measurer, trundle wheel	**B1**			tape is too vague accept rule(r)
26(a)	use of at least 3 turns	**1**			

Question	Answer	Marks	AO Element	Notes	Guidance
	(mark string and) measure distance (between marks) **and** divide by number of turns	**1**			
26(b)	any one from: • stretching of string • thickness of string • thickness of mark • gaps between turns • winding of turns at an angle	**1**			
27	any three from: - making marks / lines on track for start and finish - repeats / find average time - constant starting positions - not pushing car - time from same point on car - use light gates / data logger / automatic timer for timing - method for avoiding parallax error <u>when judging finishing point</u> / stand level with finish	**3**			
28	measuring cylinder	**1**			

Question	Answer	Marks	AO Element	Notes	Guidance
29(a)	(average thickness =) 3.8 ÷ 20 (1) (average thickness =) 0.19 (cm) (which is about 0.2 cm) (1)	**2**			
29(b)	any **one** from: wire(s) not touching wire stretched (in places) ruler not at zero (owtte) wire(s) overlapping eye not directly above ruler (owtte)	**1**			
30	(time =) 20 ÷ 50 (1) 0.4 (s) (1)	**2**			
31	(average thickness =) 2.4 ÷ 8 (1) (average thickness =) 0.3 (cm) (1)	**2**			
32(a)	13.2(0) (s)	**1**			
32(b)	13.2 ÷ 30 (1) 0.44 (s) (1)	**2**			
32(c)	reduces the effects of (timing / reaction time) errors owtte	**1**			

Question	Answer	Marks	AO Element	Notes	Guidance
33	(student) S	**1**			
34	226.50 – 82.10 **OR** 3:46.5(0) – 1:22.1(0) **OR** 2 min 24.4 (s) (1) 144.4(0) (s) (1)	**2**			
35	165 (mm)	**1**			
36	tape measure	**1**			
37	(diameter of wheel =) 0.35 (m) (1) (diameter of axle =) 0.025 (m) (1)	**2**			
38(a)	1.24 (s) **AND** 1.14 (s) **AND** 1.16 (s)	**1**			
38(b)	(1.24 + 1.14 + 1.16) ÷ 3 **OR** 3.54 ÷ 3 (1) 1.18 (s) (1)	**2**			
39	72 (s)	**1**			
40	2 : 33 : 65 – 1 : 22 : 15 **OR** 153.65 – 82.15 (1) 71.50 (s) (1)	**2**			

Question	Answer	Marks	AO Element	Notes	Guidance
					[Total: 137]