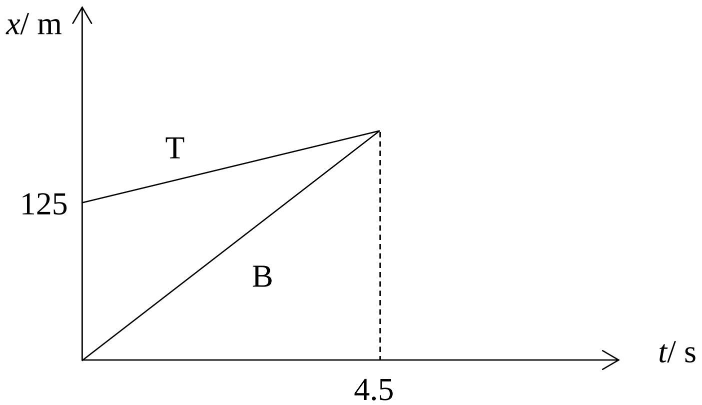
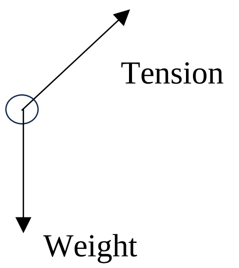
<u>Y5 IBDP EOY HL Physics Examination 2024 Marking Scheme</u>

PHYSICS P1a

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C	**B**	**C**	**D**	**A**	**D**	**D**	**B**	**A**	**B**	**D**	**C**	**C**	**D**	**B**	**C**	**B**	**A**	**C**	**B**
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
B	**A**	**B**	**B**	**B**	**D**	**B**	**D**	**D**	**C**	**C**	**B**	**D**	**B**	**C**	**D**	**A**	**D**	**C**	**B**

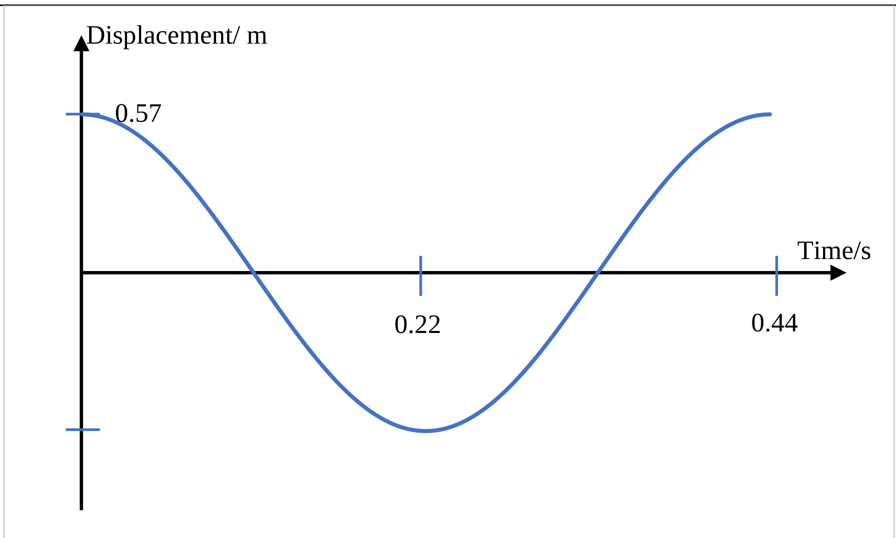
PHYSICS P1b

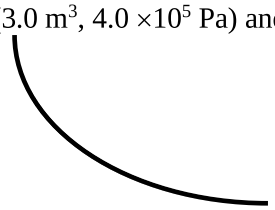
	Answer	**Marks**
1(a)(i)	uncertainty in period reduces; (you can show that % uncertainty in *T* reduces from 8.7% to 0.43%, a reduction of about 20 times) by 20 times; improves the precision of period;	2
1(a)(ii)	Human reaction time in using stopwatch; Likely to be at least $\frac{1}{10}$ th a second (0.1 s); value student recorded is too precise;	2
1(a)(iii)	T = 0.5750 ± 0.0025 s; T^2 = 0.3306 s^2 % uncertainty in T = 0.435 % Hence % uncertainty in T^2 = 0.870 %; ΔT^2 = 0.870% of 0.5750^2 = ± 0.0029 = ± 0.0003;	3
1(a)(iv)	% uncertainty in L= % uncertainty in F + 2(% uncertainty in T) + % uncertainty in m = 5.88 + 0.8696 + 0.5; = 7.3 %; *This question has an ecf full marks from 1(a)(iii).*	2
1(b) i	Plot T^2 (y-axis) vs m (x-axis) or T (y-axis) vs $\sqrt{m}$(x-axis);	1
1(b) (ii)	<m> = 202 g (± 1 g) Δm = ± ½ (210 – 195) = ±7.5 g = ± 8 g	2
2(a)(i)	The effective acceleration along the slope is equal to $g = \frac{a}{\sin\theta}$ or $a = g\sin\theta$	1
2(a)(ii)	t = 0.4 s, x = 0.2 × 100^2 cm hence g = 2x / t^2 = 250 cm s^{-2} (Choose at least greater than 0.35 s (half the graph) and easy and accurate to read the value of *x*.) Hence g = a ÷ sin 15° = 970 cm s^{-2} ; *This question has an ecf full marks from 2(a)(i).*	3
2(a)(iii)	human reaction in the time taken; take several repeats of the same measurement; determine average; <u>Alterative answer:</u> direction of wind is random and so time taken is either lower or higher than true value; minimize this random error by taking several repeats of the same measurement and determine average;	2
2(b)	(smaller acceleration) hence larger time; (% / fractional) uncertainty of time decreases;	2

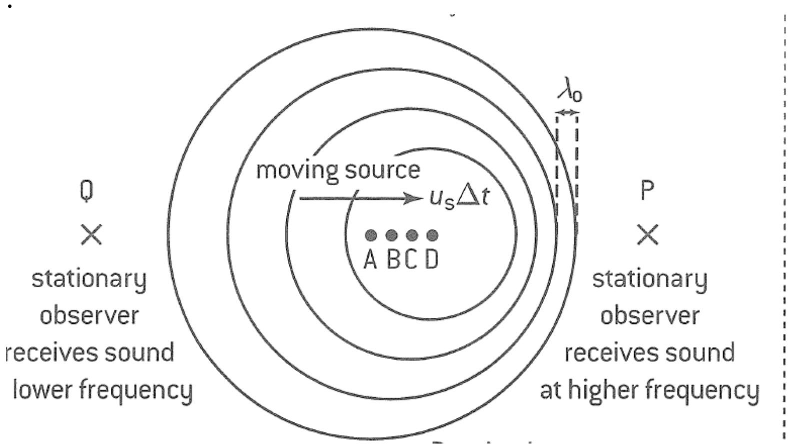
	Answer	Marks
1(a)	Using $s = ut + ½ at^2$ $y = ½ (9.8) t^2$ $100 = ½ (9.8) t^2$ $t = 4.5$ s	 1 1 1
1(b)	1 mark for each correct graph 	 1 1
1(c)	Total horizontal displacement travelled by parcel = 72 × 4.5 = 324 m Speed of truck = $\dfrac{324-125}{4.5} = 44\ \text{m s}^{-1}$ (if student uses 4.52 s from part (a), then the answer could be 44.5 or 45 ms^{-1})	1 1
2(a)	 Correct labelling and directions of forces. Correct relative magnitude of forces (vertical components). Minus 1 if relative magnitude of vertical components is obviously not correct.	1 1
2 (b)	$r = 4.00 + 2.50\ \sin 28.0^{\circ} = 5.2$ m	1
2 (c)		1

	$T\cos\theta = mg$ $T\sin\theta = \dfrac{mv^2}{r}$ $\tan\theta = \dfrac{v^2}{rg}$ $v^2 = r\,g(\tan 28.0^\circ)$ $v = \sqrt{5.17(9.81)(\tan 28.0^\circ)} = 5.2\ \mathrm{m\,s^{-1}}$	1 1
2 (d)	$T\cos\theta = mg$ $T = \dfrac{mg}{\cos\theta}$ $= \dfrac{50\times 9.8}{\cos 28}$ $= 560\ \mathrm{N}$	1 1
3 (a)	$F = kx = 75 \times 0.085$ $= 6.38$ N	1 1
3 (b)	$mgh = ½\,kx^2$ or $½\,Fx$ $0.025 \times 9.81 \times h = ½ \times 75 \times 0.085^2$ height $h = 1.1$ m	1 1
3 (c)	The maximum height is <u>reduced / lower</u>. Energy is lost to <u>work done against air resistance / resistive forces</u>	1 1
4a(i)	Heat lost by iron ball = Heat gained by copper calorimeter and water $24\times 0.451\times (T-22) = (40 \times 0.385 \times 7) + (300 \times 4.2 \times 7)$; T = 847 °C = 850 °C (2 sfs)	1 1
4a(ii)	Loss in the mass of water (due to rapid boiling occurring as the temperature of iron ball is much greater than the boiling point of water.) (The temperature T will be lower.) *Do not accept thermal energy losses by the iron water during the transfer or thermal energy losses by the water and calorimeter to the surroundings*	1
4b	by energy balance model, $I_1 = I_o + I_2 = 390\ \mathrm{W\,m^{-2}}$; $I_1 = \sigma T^4$, hence $T = \sqrt[4]{\dfrac{390}{5.67\times10^{-8}}}$ = 290 K (2 sfs); (also accept 288 K)	1 1
4c	Use $pV = nRT$; from graph $pV = 12$; Hence $T = \dfrac{12}{4.5\times10^{-3}\times8.31}$ T = 320 K (2 sfs);	1 1
5a(i)	$V_{lamp} = IR = 0.30 \times 5.0 = 1.5$ V; hence $V_{3.0\Omega} = 4.5$ V; $I_{3.0\Omega} = 4.5 \div 3.0 = 1.5$ A $R = \dfrac{1.5}{1.5-0.30} = \dfrac{1.5}{1.20} = 1.25\ \Omega$;	1 1
5a(ii)	Total power is given by $P = VI = (6.0)(1.5) = \dfrac{120}{t}$; giving $t = 13.33$ s; Hence $E_{lamp} = I^2Rt = 0.30^2 \times 5 \times 13.33$ $= 6.0$ J;	1 1 1

5a(iii)	$V = IR$ $6.0 = 1.176\,(r + 3 + 1.25)$; $r = 0.85\ \Omega$ (2 sfs);	 1 1
6ai	1) acceleration is proportional to Displacement / vice versa Because graph is straight line passing through origin 2) Displacement and acceleration are opposite in direction Acc. Towards equilibrium Also accept constant and negative gradient (makes reference to $a = -\omega^2 x$)	1 1
aii	use of $\omega^2 = (-)\frac{a}{x}$; $\omega^2 = \frac{2900}{0.60\times10^{-3}}$; $\omega = 2\pi f$; $f = \frac{1}{2\pi}\sqrt{\frac{2900}{0.60\times10^{-3}}}$; (to give f = 350Hz) (for show question, student needs to show raw value of f as 349 Hz)	1 1
bi	$= I \times A$ $P = (1.0\times10^{-2})(5.0\times10^{-5})$ $= 5.0\times10^{-7} W$ $E = Pt$ $E = (5.0\times10^{-7})(5)(60) \quad = 1.5\times10^{-4} J$	1 1
bii	No energy is lost to the surroundings/ OR all the energy is transmitted from the monitor to the eardrum. Accept sound energy is incident at right angle to the plane of the eardrum	 1
6c i	 T = 0.44 s	1
cii	$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.44} = 14.3\, rad$ $\frac{1}{2}m\omega^2 {x_0}^2 = 10$ $x_0 = \sqrt{\frac{2(10)}{(0.300)(14.3)^2}}$ $= 0.57\, m$	1 1 1
		2

6ciii	 1 mark for shape. 1 mark for proper axis labels and labelling of pertinent displacement and time values.	
7ai	wavelength$= \frac{340}{850} = 0.40$ «m» ✓ path difference $= 1.8$ «m» ✓ 1.8 «m» $= 4.5\lambda$ ***OR*** $\frac{1.8}{0.20} = 9$ «half-wavelengths» ✓ waves meet in antiphase «at P» ***OR*** destructive interference/superposition «at P» ✓ *Allow approach where path length is calculated in terms of number of wavelengths; along path A* (56.25) *and path B* (60.75) *for MP2, hence path difference* 4.5 *wavelengths for MP*	3
7aii	«equally spaced» maxima and minima ✓ a maximum at Q ✓ four «additional» maxima «between P and Q» ✓ Loud and soft sound is heard- accepted	2

7aiii	the amplitude of sound at Q is halved ✓ «intensity is proportional to amplitude squared hence» $\frac{I_A}{I_0} = \frac{1}{4}$ ✓ Allow $I \propto A^2$ for 2nd mark	2
7bi	d = $\frac{1}{8.00 \times 10^5}$ = 1.25 x 10^{-6} m d sin θ = nλ θ = $\sin^{-1}$ [$(2 x\ 589\ nm)/(1.25\ x10^{-6})$ = 70.459° θ = $\sin^{-1}$ [$(2 x\ 590\ nm)/(1.25\ x10^{-6})$ = 70.734° Δθ = 0.275° OR Ans in rad is accepted with working Δθ = 1.23455- 1.22973 = 4.81 x10^{-3} radians	1 1 1 1 4
7bii	The lines are closer together / not clearly separate in the first order spectrum hence not resolved.	1
8a(i)	I = m r^2; where m is the <u>mass</u> of the flywheel and r is the <u>radius</u> of the flywheel	2
8a(ii)	$\omega_f = \omega_I + \alpha t$ 300 = 0 + α(150); α = 2.0 rad s^{-2} ; Hence τ = I α τ = 90 × 2.0 = 180 N m;	 1 1 1
8a(iii)	E_{rot} = ½ I ω^2 = ½ (90)$(300)^2$; = 4.1 ×10^6 J ;	 1 1
8a(iv)	$W = F \times d$ 4.05 × 10^6 = 400 × d d = 1.0 ×10^4 m ;	 1
8b(i)	The **net** torque acting on the system must be zero.	1
8b(ii)	90 rev/min → f = 1.5 Hz $\omega_i = 2\pi f = 3\pi$ Similarly ω_f = 2π(1.33) = 2.66π ; Conservation of angular momentum (I_{disc})(3π) = (I_{disc} + 0.02 × 0.05^2)(2.66π) ; Solving, I_{disc} = 3.9 × 10^{-4} kg m^2 ;	 1 1 1
9a(i)	$pV = constant$ $p_2 = \frac{4.0\times10^5\times3.0}{5.0}$ $p_2 = 2.4 \times 10^5$ Pa;	 1
9a(ii)	Sketch shows the curve starts at (3.0 m^3, 4.0 ×10^5 Pa) and ends at (5.0 m^3, 2.4 ×10^5 Pa) and correct shape of the curve 	2 1

9a(iii)	W = area under the curve ≈ area of trapezium = $\frac{1}{2}(6.4 \times 10^5)(2.0)$; W = 6.4×10^5 J; (also accepts exact value using $W = nRT\ ln\frac{V_2}{V_1}$ = (4.0×10^5) (3.0) $ln\frac{5}{3}$ = 6.1×10^5 J)	1 1
9a(iv)	Less work is done because the adiabatic change will have the curve that is below the curve in part (a)(ii) and so the area under the curve will be smaller **OR** the curve representing the adiabatic change will be steeper than the isothermal change.	1
9b(i)	*W = area of the rectangle* = (2×10^5) (8.0) ; *W* = 1.6×10^6 J;	1 1
9b(ii)	Efficiency = $\frac{W}{Q_{input}} = \frac{1.6\times10^6}{(1.8+1.6)\times10^6}$; $= 0.47 = 47\%$ (2 sfs);	1 1
9c	*The second law of thermodynamics states that the total entropy of a system either increases or remains constant in any reversible process; it never decreases.*	1
10 a	diagram showing (circular) wavefronts around source, so that wavefronts are closer together on side of observer; speed of sound waves for observer is the same (as for stationary case) but observed wavelength is smaller; since $f' = \frac{v}{\lambda'}$, (observed frequency is larger); .  	3
10 b	$$f' = f\frac{v}{v-u_s}$$ = $$293 = 275\frac{330}{330-u_s}$$ Speed of the source = 20.28 = 20.3 ms^{-1}	2