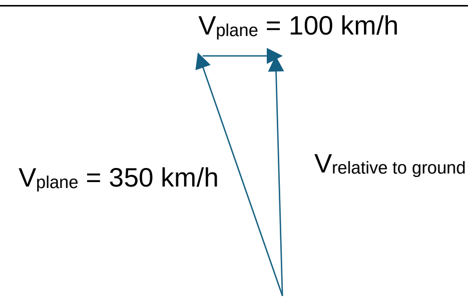
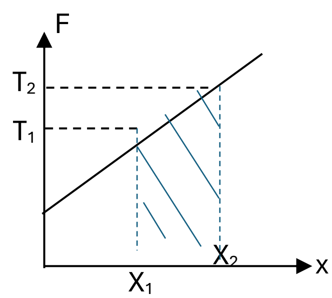
2024 H2 Prelim Paper 1 Solutions:

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	B	B	C	A	A	D	A	D	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	C	B	A	A	A	C	A	A	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	C	A	C	D	B	D	C	D	B

<table>
<tr><td>1</td><td>A</td><td>Units of $\Delta P = kgm^{-1}s^{-2}$, units of $\rho = kgm^{-3}$
Units of $\frac{\Delta P}{\rho} = m^2 s^{-2}$, hence n =0.5</td></tr>
<tr><td>2</td><td>B</td><td>Accurate → How close they are to the true value
Precise → How close the measured readings are from one another
<table>
<tr><td colspan="4">Readings d/ mm</td><td>Ave Value</td><td>Largest – smallest value</td></tr>
<tr><td>1.49</td><td>1.46</td><td>1.52</td><td>1.50</td><td>1.4925</td><td>0.06</td></tr>
<tr><td>1.48</td><td>1.58</td><td>1.51</td><td>1.40</td><td>1.4925</td><td>0.18 (not precise)</td></tr>
<tr><td>1.35</td><td>1.37</td><td>1.42</td><td>1.42</td><td>1.39</td><td>0.07</td></tr>
<tr><td>1.32</td><td>1.37</td><td>1.41</td><td>1.50</td><td>1.4</td><td>0.18</td></tr>
</table></td></tr>
<tr><td>3</td><td>B</td><td>$V_{\text{relative to ground}}$
$= \sqrt{350^2 - 100^2}$ = 335 km/h

</td></tr>
<tr><td>4</td><td>C</td><td></td></tr>
<tr><td>5</td><td>A</td><td>Change in momentum = area under F-t graph

Area under F-t graph from 0 to 10 seconds = 0.5 x (8+4) x 12 + [(-0.5) x (2) x (12)] = 60 N s

Change in momentum = final momentum – initial momentum
60 = mv – 0
v = 200 m s^{-1}</td></tr>
</table>

6	**A**	*Force by wall on water*= $\langle F_{net} \rangle = mass\ per\ unit\ time \times \Delta v$ $= \dfrac{m}{\Delta t}\Delta v = \dfrac{\rho(Vol)}{\Delta t}\Delta v \qquad since\ m = \rho(Vol)$ $= \rho\pi r^2 v(0 - v)$ $= -\rho\pi r^2 v^2$ $= -1000\pi(2.0\times10^{-2})^2(0.50)^2$ $= -0.314$ N By Newton's 3rd Law, Force by water on wall = Force by wall on water = 0.314 N
7	**D**	On each cuboid ; Volume of water displaced is the same, therefore U is constant for all cuboids of equal volume. T + U = mg T +U =ρVg (where ρ is density of material/cubpid) T = ρVg – U Since cuboid W has largest density, T on string is the largest.
8	**A**	 Extra energy stored = area of trapezium = $\dfrac{1}{2}(T_2 + T_1)(x_2 - x_1)$
9	**D**	Since P and Q have the same angular velocity, the linear speed ($v = r\omega$) of P is greater than Q as $r_1 > r_2$. Also, centripetal force ($F = mr\omega^2$) is greater for P than Q as $r_1 > r_2$.
10	**B**	At P: $N + mg = mv^2/r$ $N = mv^2/r - mg$ $v = \sqrt{rg}$ when $N \approx 0$ Since GPE at P and Q is the same, KE at P = KE at Q. At Q: $mg - N = mv^2/2r$ $N = mg - m(rg)/2r$ $N = mg/2$

11	**D**	*By conservation of energy,* $KE_i + GPE_i = Ke_f + GPE_f$ $0+\left(-\frac{GMm}{7R}\right)=½mv^2+\left(-\frac{GMm}{R}\right)$ $v=\sqrt{\frac{12GM}{7R}}$
12	**C**	The antenna will have the same speed as the space-craft and is still bound in orbit. There is still gravitational force acting on it which causes it to move in circular motion.
13	**B**	$PV=\frac{1}{3}Nm<c^2>$ *V* and *m* remain unchanged $\Rightarrow \frac{N<c^2>}{P}$ = constant $\Rightarrow \frac{N\times 3.0\times 10^5}{P}=\frac{\frac{3N}{4}<c^2>}{\left(P/2\right)}$ $\Rightarrow$ N = 2.0 $\times 10^5$ m^2 s^2
14	**A**	This is an SHM question and the E_p graph is **A**, lowest at the equilibrium and maximum at the amplitudes (opposite from the KE-r graph).
15	**A**	ma = mg – R Object will remain in contact when R is greater than 0. Object will lose contact when R = 0, ma = mg For SHM, a = $\omega^2 x_o = (2\pi f)^2 x_o$ = g $x_o = \frac{g}{(2\pi f)^2} = \frac{9.81}{(2\pi(2.0))^2}$ = 9.81/$(2\pi(3.0))^2$ = 0.028 m
16	**A**	$I=kA^2$ Resultant amplitude when antiphase = $A-0.6A=0.4A$ Resultant intensity $I_R=k(0.4A)^2=0.16kA^2=0.16I$

17	**C**	Using $I = I_o cos^2 \theta$ For diagram 1, 2 = 8 $\cos^2 \theta$ $\Rightarrow \quad \theta = 60^o$ For diagram 2, when rotated another 90°, $I = 8cos^2(90+60)$ = 6 W m^{-2}
18	**A**	$tan\theta = \frac{20}{75} \Rightarrow \theta$ = 14.9° Using $d\,sin\theta = n\lambda$ where $d = \frac{1}{N}$, $\frac{10^{-3}}{300} sin14.9^o = 2\lambda$ $\Rightarrow \lambda$ = 429 nm
19	**A**	E field point from high *V* to low *V* $\Rightarrow$ E field point towards right Since electron is -vely charged, electric force on electron points towards X or away from Y. Change in EPE from X to Y = EPE_Y - EPE_X = $-eV_Y - (-eV_X)$ = - 70 eV + 100 eV = +30 eV
20	**C**	$R = \frac{\rho L}{A} \propto \frac{L}{A}$ $\frac{R'}{R} = \frac{L'}{L} \times \frac{A}{A'}$ $\frac{R'}{4.0} = \frac{5d}{d} \times \frac{d^2}{2d(d)}$ $R' = 10\ \Omega$
21	**D**	In the driver circuit, the p.d. across XY should be minimized, so the resistance of the NTC thermistor needs to be maximised, according to potential divider rule. Hence, the temperature should be low. The terminal p.d. of the test circuit should be maximised, so the resistance of the LDR needs to be maximised. Hence, the environment should be dark.
22	**C**	$\frac{V_s}{V_p} = \frac{N_s}{N_p} \Rightarrow V_s = \frac{130}{2500} \times 230 = 12$ V Peak power = $\frac{V_o^2}{R} = \frac{(\sqrt{2} \times 12)^2}{6} = 48$ W

23	**A**	Taking moments about pivot, $F_B \times L\cos 30° = 0.12 \times \frac{L}{2}\sin 30°$ $50B(0.40)(60\times10^{-3})\cos 30° = 0.12\times\frac{1}{2}\sin 30°$ $B = 0.029$ T
24	**C**	Force causing deflection acts upwards hence magnetic force is upwards. Using Fleming's left hand rule, current is opposite in direction to motion of particle so it must be negatively charged. If direction of magnetic force is upwards, electric force must be downwards so electric field must be upwards
25	**D**	Maximum flux linkage occurs when the B field lines are perpendicular to coil, i.e. either $\frac{\pi}{3}$ anticlockwise. When flux linkage is maximum , induced e.mf. will be minimum (zero) and vice-versa.
26	**B**	Step up transformer $\Rightarrow$ no. of turns in secondary coil N_s > no. of turns in primary coil N_p Since magnetic flux ϕ in both coil is equal as it is an ideal transformer, $N_s\phi > N_p\phi$ Ideal transformer $\Rightarrow$ $\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s} < 1$
27	**D**	
28	**C**	$E = ½ m v^2 = p^2/ 2m$ $p = (2mE)^{1/2}$ (m of alpha particle = 4u) $= (8uE)^{1/2}$ $\lambda = h / p = h / (8uE)^{1/2} = h / 2(2uE)^{1/2}$
29	**D**	α will not pass through paper β is stopped by a few cm of aluminium foil only γ can pass through thick steel
30	**B**	$P = \frac{E}{t} = \frac{mc^2}{t}$ $= \frac{(6.0\times10^{-6})(3.00\times10^{8})^2}{60\times60}$ $= 1.5\times10^{8}$ W