2022 SH1 H2 Physics (9749)
Promotional Examination Paper 1

Answers

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

Workings/Explanations

1	**P − Q = P + (−Q)** **P** is rightwards. **−Q** is upwards. **P − Q** is diagonally rightward and upward.
2	Accuracy is related to systematic error and Precision is related to random error. Having little systematic error means that the results are accurate. Why A is wrong – Removing systematic error such as zero error improves accuracy. Why B is wrong – Taking the mean value of the experiment reduces random error and improve precision and does not affect the accuracy. Why C is wrong – If mean value is close to the true value, then it is accurate.
3	2(1%) + 2% + 2% = 6%
4	The first ball bearing always has a larger speed than the second, so the distance between them keeps increasing.
5	height of object above ground – always decreasing (with decreasing gradient) until reaches constant negative gradient at terminal velocity therefore Y speed of object – starts from zero always increasing until remain constant at terminal velocity therefore Z magnitude of resultant force on object – decreasing (due to air resistance increasing and weight remaining constant) until reaches zero at terminal velocity therefore X
6	Let initial velocity of elevator be *u* (so it is the same for the ball). At time *t* the ball hits the floor of elevator. For ball: $s_{\text{ball}} = ut - \frac{1}{2}gt^2$ (this is the displacement from its initial position) For floor: $s_{\text{floor}} = ut + \frac{1}{2}\times 5.8t^2$ When they meet, taking reference from the floor as the initial position, (since ball is 2.0 m above floor, it has an initial displacement of 2.0 m) $s_{\text{floor}} = s_{\text{ball}} + 2.0$ $ut + \frac{1}{2}\times 5.8t^2 = ut - \frac{1}{2}\times 9.81t^2 + 2.0$ $t = 0.51$ s
7	rate of change of momentum = resultant force = $\sqrt{(10000-9000)^2+500^2}$ = 1100 kg m s^{-2}
8	impulse = change in momentum = 0.100 (−30 − 20) = −5.0 N s
9	linear momentum of 2.0 kg trolley = 2.0 (2.0) = 4.0 kg m s^{-1} (left)

[Turn over

	therefore linear momentum of 1.0 kg trolley is 4.0 kg m s^{-1} (right) by Conservation of Linear Momentum since Initial Total Linear Momentum is zero therefore speed of 1.0 kg trolley = 4.0 m s^{-1} energy stored in spring = Total final kinetic energy = ½ (2.0)$(2.0)^2$ + ½ (1.0)$(4.0)^2$ = 12 J
10	The lines of action of *F*, the weight of the barrel and the resultant force of the ramp must meet at a common point so that resultant moment about that point is zero. The three forces will also form a closed vector triangle to ensure resultant force acting on the barrel is zero.
11	Take moments about the pin: Anti-clockwise moment = Clockwise moment $F \times \left(r + r\cos 40^\circ\right) = 20 \times r\sin 40^\circ$ *F* = 7.3 N
12	The same mass of sand displaces a smaller volume of air. Upthrust on sand is less than that for cotton. Contact force + upthrust = weight Contact force on the balance is larger for sand, so its reading is larger.
13	Total work done = $100 \times 40 = 4000\ \text{J}$ Gain in gravitational potential energy = $mgh = 20.0 \times 9.81 \times 12 = 2354\ \text{J}$ Work done against friction = work done by friction = $4000 - 2354 = 1645\ \text{J}$
14	At (constant maximum) velocity, driving force of the car = resistive force = kv The required power for (constant maximum) velocity = $Fv = kv^2$
15	From graph, extension with 10 N load = 0.040 m Therefore area under graph from 0.040 m to 0.080 m = ½(10+20)(0.080 − 0.040) = 0.600 J OR Elastic potential energy with 10 N load = $\frac{1}{2}kx^2$ = ½(10/0.040)$(0.040)^2$ = 0.200 J Elastic potential energy at additional 0.040 m extension = ½(10/0.040)$(0.080)^2$ = 0.800 J Additional elastic potential energy = 0.800 − 0.200 = 0.600 J
16	Horizontally: $P\sin\theta = mr\omega^2$ where tension: P Vertically: $P\cos\theta = mg$ Hence, $\tan\theta = \frac{r\omega^2}{g} = \frac{r}{g}\left(\frac{4\pi^2}{T^2}\right) \Rightarrow T = \sqrt{\frac{4\pi^2 r}{g\tan\theta}}$
17	Let the magnitude of the contact force be F Vertical component of contact force F balances weight $F\sin\theta = mg \ldots (1)$ Horizontal component of F provides centripetal force $F\cos\theta = \frac{mv^2}{r} \ldots (2)$ $\frac{(1)}{(2)} : \tan\theta = \frac{gr}{v^2} = \frac{9.81(30)}{20^2} = 0.73575$ $\theta = \tan^{-1}(0.73575) = 36°$

18	KE at top of circle $=$ KE at bottom of circle-gain in GPE $=\frac{1}{2}(1.27)(5.75^2)-(1.27)(9.81)(1.2)$ $=6.044$ J Linear speed at top of circle: $\frac{1}{2}mv^2=6.044$ $v=3.085$ m s^{-1} Tension at top, $T=F_C-mg$ $=\frac{(1.27)(3.085^2)}{0.6}-(1.27)(9.81)$ $=7.689$ ≈ 7.69 N
19	Elastic potential energy is proportional to the square of the extension of the spring. Gravitational potential energy (near the surface of the Earth) is proportional to vertical distance. Kinetic energy is zero at the extreme ends of the oscillation and maximum at the equilibrium.
20	A is wrong as velocity cannot be positive all the time. B and D are wrong because the shape of the graphs are different. Only C is possible. Kinetic energy and time will have a graph similar to a $\sin^2(\omega t)$ or $\cos^2(\omega t)$ graph, although the graph may be shifted.
21	$F = W + U$ At $d = D$, $F = 0$ (equilibrium) Since W is a positive constant (taking downwards as positive), F is parallel to U and is shifted upwards from U $U = -\rho gV = -\rho gA\ d$ (Note: U is upwards hence negative. ρ, g and A are constants.) U-d graph is downward sloping straight line (constant gradient) and passes through the origin (extend the U line to check that it passes through the origin)
22	Point Q is momentarily stationary when maximum displacement. Point P is moving downwards which can be seen if we imagine the wave to have moved to the right a short time later.
23	$T_X = 3T_Y$ hence $T_Y = \frac{1}{3}T_X$ $f_Y = \frac{1}{T_Y} = \frac{1}{\frac{1}{3}T_X} = \frac{3}{T_X} = 3f_X$ $A_Y = \frac{1}{2}A_X$ Since $I \propto f^2$ and $I \propto A^2$, $I = kf^2A^2$ $I_X = I = k{f_X}^2{A_X}^2$ $I_Y = k{f_Y}^2{A_Y}^2 = k(3f_X)^2\left(\frac{1}{2}A_X\right)^2 = \frac{9}{4}k{f_X}^2{A_X}^2 = \frac{9}{4}I$
24	Malus' Law, $I' = I\cos^2 60.0° = 0.250\ I$

25	Using Rayleigh's criterion, $\theta_R \approx \frac{\lambda}{d}$ The smaller the value of θ_R, the better the resolution because smaller details can be resolved. Therefore, the telescope with the best resolution is the telescope with the smallest ratio of $\frac{\lambda}{d}$. **telescope** λ/d **resolution** (i) 5.0×10^{-7} Worst (ii) 5.0×10^{-8} Best (iii) 3.3×10^{-7} Hence, in the order from the worst resolution to the best resolution, it will be (i), (iii), (ii).
26	Angular displacement cannot be smaller (either same or larger) as smaller means they are closer and therefore more difficult to distinguish. Wavelength cannot be longer (either same or shorter) as longer wavelength means the minimum angular displacement at which they can be distinguished is larger.
27	$d = \frac{\lambda L}{x}$ $d_{\text{new}} = \frac{(2\lambda)(0.5L)}{4x} = 0.25\frac{\lambda L}{x} = 0.25d$
28	Geo-stationary satellite has the same period as the period of 24 hours. Same period also means same angular velocity. Kepler's Law states that for a given period the distance is fixed. So the centripetal acceleration is also the same. **Kinetic energy may be different as different satellite may have different mass.**
29	$g = \frac{GM}{R^2}$ $\frac{g_{2R}}{g_R} = \frac{R^2}{(2R)^2}$ $\frac{g_{2R}}{g} = \frac{R^2}{4R^2}$ $g_{2R} = \frac{1}{4}g$
30	$\frac{GMm}{r^2} = mr'(\frac{2\pi}{T})^2$ $\frac{G(4.0 \times 10^{30})}{(2.0 \times 10^{11})^2} = (1.0 \times 10^{11})(\frac{2\pi}{T})^2$ $T = 2.4 \times 10^7$ s