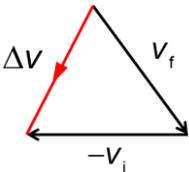


Qn	Ans	Discussion
1	C	<p>The object travels at the same speed. Hence, <math> v_f  =  v_i </math>.</p> $\Delta v = v_f - v_i$ $= v_f + (-v_i)$ 
2	A	<p>For the upward motion, air resistance and gravitational force are both acting downwards, acceleration is greater than the acceleration of free fall and hence it decelerates faster to reach the maximum height. As for the downward motion, air resistance and gravitational force are in opposite directions and the resultant force equals to gravitational force minus the air resistance. Acceleration is smaller than the acceleration of free fall and hence it accelerates slower downwards than it decelerates upwards.</p>
3	D	<p>Consider cart 3 and cart 4 as single object of mass 800 kg. Only <math>T</math> is acting on this object. <math>F = ma</math> <math>T = 800 (2) = 1600 \text{ N}</math></p>
4	A	<p>Assuming the mass of each ball is <math>m</math>.</p> <p>Since total initial momentum = <math>mv</math> By Conservation of linear momentum, total final momentum should be <math>mv</math></p> <p>A) Total final momentum = <math>0 + mv = mv</math> B) Total final momentum = <math>\frac{mv}{2} + \frac{mv}{2} = mv</math> C) Total final momentum = <math>\frac{3mv}{4} - \frac{mv}{4} = \frac{1}{2}mv</math> D) Total final momentum = <math>mv - mv = 0</math></p> <p>Only A and B's momentum are conserved.</p> <p>Elastic means relative velocity of approach = relative velocity of separation By relative velocity of approach and separation, KE not conserved for option B.</p>
5	A	<p>By conservation of energy, elastic potential energy is converted to kinetic energy and work done against friction. As height is the same at initial and final positions, gravitational potential energy is unchanged.</p> $EPE_{\text{loss}} = KE_{\text{gain}} + WD_{\text{friction}}$ $\frac{1}{2}kx^2 = (KE_{\text{final}} - KE_{\text{initial}}) + fd$ $KE_{\text{final}} = \frac{1}{2}kx^2 - fd \quad (\text{since } KE_{\text{initial}} = 0)$

6	D	$N - mg = \frac{mv^2}{r}$ $N = mg + \frac{mv^2}{r}$ $= 0.52 \left( \frac{9.3^2}{1.3} + 9.81 \right)$ $= 39.7$ $\approx 40 \text{ N}$
7	A	<p>Resultant <math>g = 2 \times \frac{(6.67 \times 10^{-11})(30)}{(\sqrt{10^2 + 10^2})^2} \cos 45^\circ</math></p> $= 1.4 \times 10^{-11} \text{ N kg}^{-1} \text{ upwards}$ <p>Resultant <math>\phi = 2 \times -\frac{(6.67 \times 10^{-11})(30)}{(\sqrt{10^2 + 10^2})}</math></p> $= -2.8 \times 10^{-10} \text{ J kg}^{-1}$
8	C	$E_k \text{ at } r = \frac{GMm}{2R} = 3.2 \text{ MJ}$ $E_p \text{ at } r = -\frac{GMm}{R} = -6.4 \text{ MJ}$ $E_p \text{ at } 2r = -\frac{GMm}{2R} = -3.2 \text{ MJ}$
9	B	<p>Since they have the same volume and pressure initially, they must have the same <math>T</math>. Therefore when the partition is removed, the <math>P</math> and <math>T</math> remains the same.</p>
10	B	<p>Since temperature is the same, the average kinetic energy is the same.</p> $\langle E_k \rangle = \frac{1}{2} m \langle c^2 \rangle$ $\langle c^2 \rangle \propto \frac{1}{m}$ $\frac{c_{rms,X}}{c_{rms,Y}} = \sqrt{\frac{m_Y}{m_X}}$ $= \sqrt{\frac{1}{2}}$ $= 0.71$
11	B	$\Delta U = Q + W$ <p>For path 1,  <math display="block">\Delta U = 10 + (-4) = +6 \text{ J}</math>         For path 2, <math>\Delta U</math> is the same.  <math display="block">6 = Q + (-2)</math> <math display="block">Q = +8 \text{ J}</math> </p>

12	A	Characteristic of heavy damping.
13	C	$a_0 = \omega^2 x_0$ $6.0 = \omega^2 (0.30)$ $\omega = 4.47$ $\approx 4.5 \text{ rad s}^{-1}$
14	B	P and S are at the centre of regions of compression. T is at the centre of a region of rarefaction. The centre of regions of compression has a phase difference of $\pi$ from the centre of regions of rarefaction.
15	D	$T = 4(4.0 \times 10^{-5}) = 1.6 \times 10^{-4} \text{ s}$ $f = \frac{1}{T} = \frac{1}{1.6 \times 10^{-4}} = 6250 \text{ Hz}$ $\lambda = \frac{v}{f}$ $= \frac{330}{6250}$ $= 5.3 \text{ cm}$
16	B	$\lambda = \frac{ax}{D}$ $x = \frac{\lambda D}{a}$ <p><math>x</math> is directly proportional to <math>\lambda</math>. However, the graph does not start from the origin.</p>
17	B	$\theta \approx \frac{\lambda}{b}$ <p>applying small angle approximation,</p> $\frac{x}{D} = \frac{\lambda}{b}$ $x = \frac{\lambda D}{b}$ $= \frac{(0.40 \times 10^{-6})(2.8 \times 10^{25})}{5.1}$ $= 2.2 \times 10^{18} \text{ m}$
18	D	$\text{no. of wavelengths} = \frac{33.5}{12} = 2.79$ <p>Since X is an intensity maxima (antinode), an intensity minima (node) will be detected at <math>0.25\lambda</math>, <math>0.75\lambda</math>, <math>1.25\lambda</math>, <math>1.75\lambda</math>, <math>2.25\lambda</math> and <math>2.75\lambda</math> away from X.</p>

19	C	Between parallel charged plates, the electric field $E$ is uniform. Hence, the force $F = qE$ experienced by the $\alpha$ -particle is uniform at any position in between the two plates.
20	D	Option A is incorrect as potential is a work done per unit charge / work done per unit mass. Option B is incorrect as potential is inversely proportional to $r$ and not $r^2$ . Option C is incorrect as electric potential can be positive if the object is positively charged. Option D is correct since moving along a field line implies moving from one equipotential line to another so the potential changes.
21	A	$I = nevA$  $v = I / neA$ since $I, n, e$ are constants $v \propto 1/A \propto 1/d^2$ $\frac{v_y}{v_x} = \frac{d_x^2}{d_y^2}$  $\frac{v_y}{v_x} = \frac{(d)^2}{(2d)^2} = 0.25$
22	A	As $V$ increases, $I/V$ ratio increases, $V/I$ ratio decreases, $R$ decreases.
23	B	Effective resistance of right portion increases. Using potential divider principle, S is brighter than before, while P and R are dimmer than before.
24	A	Using the right-hand grip rule at each wire position, the resultant magnetic field due to the contributions from the four wires are as follows: - Downwards at P - Rightwards at Q - Upwards at R - Leftwards at S
25	D	Electron experiences a magnetic force out of the page. $F_B = Bev \sin \theta$ For it to remain undeflected, the electric force must have the same magnitude. Hence, $E = \frac{F_E}{e} = Bv \sin \theta$ The electric force must point into the page. Since an electron is negatively charged, the electric field points out of the page.

26	B	$\Delta\phi \text{ for one rotation} = BA$ $\text{magnitude of } \varepsilon = \frac{d\phi}{dt}$ $= \frac{BA}{T}$ $= \frac{B(\pi r^2)}{\left(\frac{2\pi}{\omega}\right)}$ $= \frac{1}{2}Br^2\omega$ $= \frac{1}{2}(0.23)(0.65)^2(120)$ $= 5.8 \text{ V}$	<p>Alternatively,</p> $\text{magnitude of } \varepsilon = \frac{d\phi}{dt}$ $= B \frac{d}{dt} \left( \frac{1}{2} r^2 \theta \right)$ $= B \left( \frac{1}{2} r^2 \right) \left( \frac{d\theta}{dt} \right)$ $= \frac{1}{2} Br^2 \omega$ $= \frac{1}{2} (0.23)(0.65)^2 (120)$ $= 5.8 \text{ V}$
27	B	<p>For a rectified square wave,</p> $V_{\text{rms}} = \sqrt{\frac{V_0^2 \left(\frac{T}{2}\right)}{T}}$ $= \frac{V_0}{\sqrt{2}}$ $P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R}$ $= \left(\frac{V_0}{\sqrt{2}}\right)^2 \frac{1}{R}$ $= \frac{V_0^2}{2R}$	
28	D	$\text{energy of photon} = \frac{hc}{\lambda}$ $= \frac{(6.63 \times 10^{-34})(3.0 \times 10^8)}{(650 \times 10^{-9})}$ $= 1.9 \text{ eV}$ <p>Transition from <math>E_3</math> to <math>E_2</math> gives the same energy.</p>	
29	B	<p>The p.d. through which the electrons are accelerated will increase the kinetic energy of the electrons. This will increase the maximum energy of X-rays emitted, reducing the cut-off wavelength of the spectrum. The characteristic wavelengths remain unchanged as the target is not changed.</p>	

<b>30</b>	<b>A</b>	<p>The correct answer describes a piece of evidence that uniquely identifies <math>\alpha</math>-radiation.</p> <ul style="list-style-type: none"><li>- Option A is correct because the count rate only reduces significantly 1 cm away from the source in air if it is <math>\alpha</math>-radiation. <math>\beta</math> and <math>\gamma</math> radiation have greater penetrating power.</li><li>- Option B is incorrect because a lead block can shield <math>\alpha</math>, <math>\beta</math> and <math>\gamma</math> radiation.</li><li>- Option C is incorrect because both <math>\alpha</math> and <math>\beta</math> particles are charged and can be deflected by a perpendicular electric field.</li><li>- Option D is incorrect because a parallel magnetic field will not deflect <math>\alpha</math>, <math>\beta</math> and <math>\gamma</math> radiation.</li></ul>
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