2018

E 1, The tension force from the string is perpendicular to the motion of the ball

There fore, The kinetic energy is conserved.

$$\frac{1}{2}m(v_1)^2 = \frac{1}{2}m(v_2)^2$$

$$V_1 = V_2$$

2, C The angular velocity of the ball is the same to the angular velocity near the center.

There fore : the speed of string wrapping around the cylinder

$$= \omega \cdot R$$

$$\begin{cases} \frac{V}{L} = w \\ wR = \text{speed wrapping around} \end{cases} \quad \text{and} \quad \frac{V}{L} \cdot R = \text{speed wrapping around}$$

substitude V_1 and L_1

$$\frac{R}{L_1} \cdot V_1 = \text{speed wrapping around}$$

3, C

The total energy $E_T = E_K + E_G$

$$= \frac{GMm}{2R} - \frac{GMm}{R}$$

$$= -\frac{GMm_1}{2R}$$

[Assuming there is a larger circle for the planet at every point]

since, $R_1 > R_2 > R_3$

therefore, $E_1 > E_2 > E_3$

4, A

First get an expression for the period

$$T = \frac{2\pi r}{V} \qquad \frac{mv^2}{r} = BqV$$

$$T = \frac{2\pi m}{Bq} \qquad V = \frac{Bqr}{m}$$

since, $m_2 = 2m_1$

$Q_2 = \frac{Q_1}{4}$

$B_2 = 3B_1$

$$T = \frac{2\pi(2m_1)}{\frac{Q_1}{4} \cdot 3B_1} = \frac{8}{3} \cdot \frac{2\pi m}{Bq} = \frac{8}{3}T$$

5, E

If we Break the circuit into parts

$$= \frac{R}{3} + \frac{R}{6} + \frac{R}{3}$$

$$= \frac{5}{6}R$$

6, A

$$\frac{1}{K_T} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3} \cdots + \frac{1}{k_{n-1}}$$

$$\Downarrow$$

$$\frac{1}{K_T} = \frac{1}{k} + \frac{1}{2k} + \frac{1}{4k} + \frac{1}{8k} + \cdots + \frac{1}{2^{n-1}k}$$

$$= \frac{1}{k} \sum_{i=1}^{\infty} \frac{1}{2^{n-1}}$$

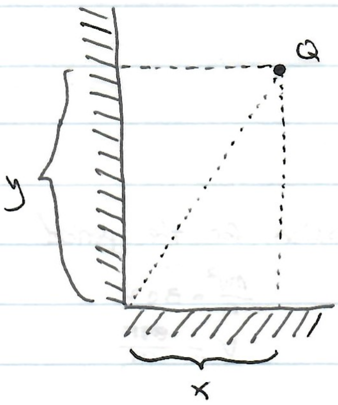
$$\frac{1}{k_T} = \frac{2}{k}$$

$$k_T = \frac{k}{2}$$

7,

8. NO answer (Question cancelled)

9, A



$y > x \Rightarrow$ Fe by ~~x~~ y is larger than Fe by y side

Fe is attracting the Q

$$\Downarrow$$

A

10, D

The knitting rate is constant $\longrightarrow \frac{dv}{dt}$ is constant

$$\frac{10^3\pi \cdot \frac{4}{3} - 15^3\pi \cdot \frac{4}{3}}{5-0} = -1988.66 = \frac{dv}{dt}$$

$$10^3\pi \cdot \frac{4}{3} - 1988.66 \cdot 2 = 209.34 = \frac{4}{3}\pi r_{new}^3$$

$$r = 3.68\,cm$$

11, A

When the gas is expelled the pressure gradually increases, However, on a certain point the P(outflow) is larger than P(inflow) and A_1 is closed. therefore, on a certain point, the slope of the P-V graph would instantly decrease, and only A fulfills this requirement.

12, A

2 balls are sticked closely to each other, so it is reasonable to consider 2 balls as 1 larger sphere. According to the conservation of gravitational energy, the height remains 1m

13, D

$$\frac{1}{2}g(t+1)^2 = vt + \frac{1}{2}gt^2$$
$$2t+1 = \frac{2vt}{g}$$
$$2t+1 = 5.3t$$
$$t = 0.303$$

$$26(0.303) + \frac{1}{2}(9.8)(0.303)^2$$
$$= 8.33m$$

Calculate the time needed for 2 balls to reach the ground at the same time.

14. ~~D~~ C

$hf = 6.62\times10^{-34} \cdot 430\times10^{14}$ = energy per photon

$P_{\text{of the light bulb}} = IV = 12\times10^{-3} \cdot 3$

$\frac{P}{hf}$ = # of protons

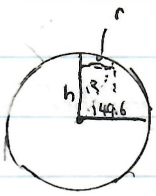
$= 1.26\times10^{17}$

15, B there's only a gravitational force and an air resistance force acting on the ball.

16, B

Air resistance is proportional to the velocity of the ball going upward. As the ball continues to ascend, the velocity decreases due to air resistance and the gravitational force. Therefore, the net force is decreasing.

17, B



$$r^2 + h^2 = R^2$$
$$r^2 + R^2\sin^2\theta = R^2$$
$$r^2 = R^2\cos^2\theta$$
$$0.648R = r$$

w = angular velocity of earth

$= 7.292\times10^{-5}$ rad/s

$v = wr = 7.292\times10^{-5} \cdot 0.648 \cdot 6.371\times10^6$

$= 301.043$ m/s

18) A

1) 6 results to throw one $\rightarrow$ $\frac{1}{6}$ of chance

2) 3 odd numbers possible in each throw, 1, 3, 5. and there is $\frac{1}{2}$ of chance to get an odd number for all three times the possibility is $\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}=\frac{1}{8}$

$$\frac{1}{6}>\frac{1}{8}$$

19) D

$$I = 49 \frac{\text{part}}{\text{sm}^2} \qquad I_0 = 1{,}000 \frac{\text{part}}{\text{sm}^2}$$

$$I = I_0 e^{-\frac{t_p}{\tau}}$$

$$(49) = (1000)e^{-\frac{t_p}{2.2\times10^{-6}}}$$

$$\boxed{t_p = 7\times10^{-6}\ \text{s}}$$

$$t_p = \frac{10\times10^3}{v}$$

$$\frac{10\times10^3}{v} = \frac{t_p}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

$$\Downarrow$$

$$v = 2.93\times10^8\ \text{m/s} \Rightarrow 0.98c$$

20) E

Object escape the gravity when

$$E_T = E_K + E_g = 0$$

and the kinetic energy doesn't depend on the launching angle.

21) A, B or C

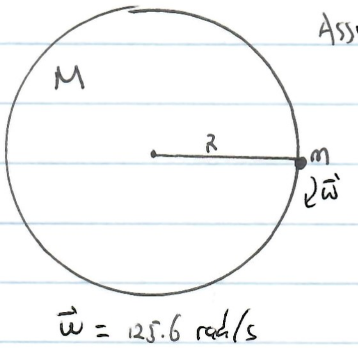
It depends on how u understand the word "unplug"

If "unplug" means solely removing the light bulb, then the answer is A or B

If it means to break that part of the circuit and disconnect the circuit, then the answer is C

Method: Try removing each bulb 1 by 1, and you shall find the answer.

22) A



$\vec{\omega} = 125.6$ rad/s

Assuming there is a mass "m" at the edge of the Radius

$$\frac{GMm}{R^2} = m\omega^2 R$$

$$M = \frac{\omega^2 R^3}{G} = \frac{4}{3}\pi R^3\cdot\rho$$

$$\Rightarrow \rho = \frac{3\omega^2}{G\pi\cdot4}$$

$$= 5.64\times10^{13} \Rightarrow \boxed{A}$$

23) B

gamma particle doesn't have charge, no magnetic force acts on it
Alpha particle is a positively charged particle, following the right hand rule, it turns left.
Beta particle is a negatively charged particle, it turns right.

24) B

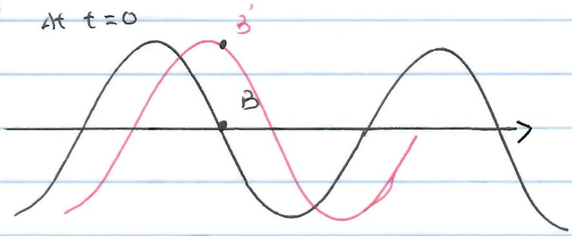
1) the acceleration in both cases are the same

case 1: $\begin{cases} m_1 a = F - N_1 \\ m_2 a = N_1 \leftarrow \text{contact force} \end{cases}$

case 2:

$\begin{cases} m_2 a = F - N_2 \\ m_1 a = N_2 \end{cases}$ $m_1 a < m_2 a$ $\Downarrow$ $N_2 < N_1 \Rightarrow \boxed{B}$

25) D



▭ means at $t = t_1$

since the wave is moving to the right in $\vec{v}$, the point 'B' would shift up.

26) D

The wavelength is 6m and when the distance between 2 speakers, or the phase difference, is $\frac{\lambda}{2}$, 2 speakers cancel the sound entirely.
As the S' moves away from the "$\frac{\lambda}{2}$ point", the sounds get louder.
therefore, D perfectly corresponds with the answer.