1) D

After B is cut, the sphere enters into a circular motion.

Before: $T_A\cos\theta \;\; mg\cancel{\cos\theta}$ $\qquad T_A \sin\theta = T_B$

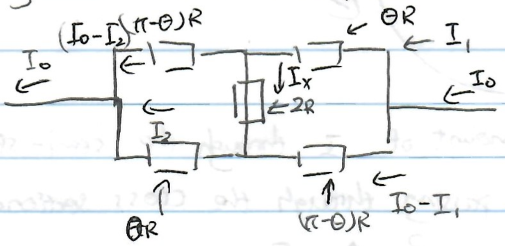
After: $m\frac{v^2}{r} = T_{A2} - mg\cos\theta$ and $v=0$

$$T_{A2} = mg\cos\theta \qquad T_A = \frac{mg}{\cos\theta}$$

$$\frac{T_{A2}}{T_A} = \cos^2\theta$$

2) D

Breaking this circuit into parts



By reflection and symmetry, it is obvious that

$$I_1 = I_2$$

and $I_x = I_1 - (I_0 - I_1) = 2I_1 - I_0$

By Kirchhoff's Law:

$$-I_1(\theta R) - (I_0-I_1)(\pi-\theta)R + I_2\theta R + (I_0-I_1)(\pi-\theta)R$$

$$= -I_x(2R) + (I_0-I_1)(\pi-\theta)R - I_1\theta R$$

$$\Downarrow$$

$$-I_1\theta - \cancel{(I_0-I_1)(\pi-\theta)} + I_2\theta = -I_x(2) + (I_0-I_1)(\pi-\theta) - I_1\theta$$

$$I_2 - I_1 = 0 \qquad 2I_x = I_0\pi - I_0\theta - I_1\pi + I_1\theta - I_1\theta$$

$$2I_x = I_0(\pi-\theta) - I_1\pi$$

$$2I_x = I_0(\pi-\theta) - \left(\frac{I_x+I_0}{2}\right)\pi$$

$$4I_x = 2I_0(\pi-\theta) - (I_x+I_0)\pi$$

$$(4+\pi)I_x = 2I_0(\pi-\theta) - I_0\pi$$

$$I_x = \frac{I_0\pi - 2I_0\theta}{4+\pi}$$

$$I_x = \frac{\pi-2\theta}{4+\pi} I_0$$

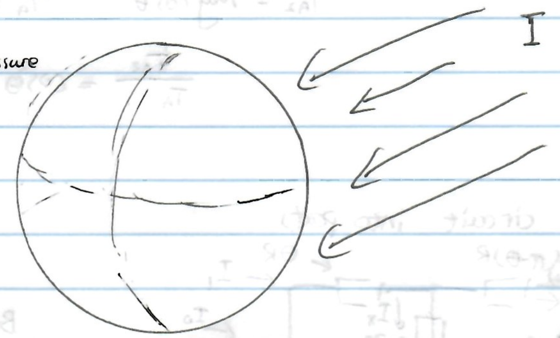
3) C

since F_f is ~~per~~ proportional to the speed of the car
F_f must be increasing when v is increasing then drop by a little bit.

4) B

$\frac{P}{4\pi R^2} = I$ R = radius of Earth orbits

$\frac{I}{c}\cos\theta =$ Pressure



By gauss's Law the amount of I through the semi-spherical ~~se~~surface is equal to to amount of I_2 passing through the cross sectional Area of Earth.

Therefore, $\frac{P}{4\pi R^2} = I$ $P_{re} \cdot A = F$

$\frac{P}{4\pi R^2 c} \cancel{\cos\theta} \cancel{2}\pi r^2 = F$

$F = 5.84 \times 10^8$

5) A

$V_f = V_i + \beta_c \Delta T$ $V_{fw} = V_{iw} + \beta_w \Delta T$

Before : $mg = \rho_w g V_i$

After $mg = \rho_{w2} g \cdot P_{in} \cdot V_{fc}$

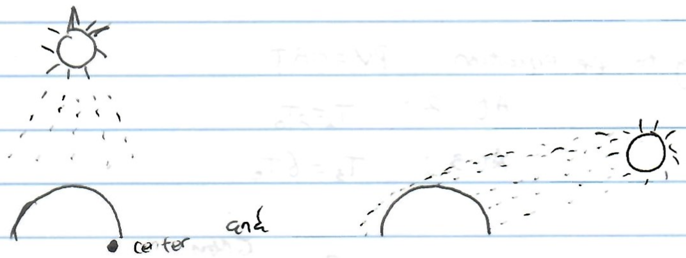
$P_{in} = \frac{m}{\rho_{w2} \cdot V_{fc}}$ $\rho_{w2} = \frac{\rho V_i}{V_{fw}} = 1.00402\rho$

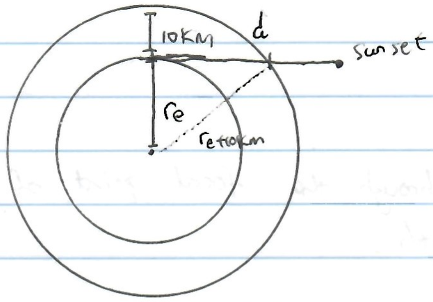
$V_{fc} = 1.00015 V_i$

Plug in, and

$P_{in} = 0.9961$ $P_{out} = 1 - P_{in} = 0.0039 = 0.39\%$

6) B





$$d = \sqrt{(re + 10km)^2 - re^2}$$

$$d = \sqrt{re^2 + 20km\,re + 100km - re^2}$$

$$d = 356960 \approx 357km$$

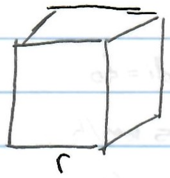
$$\frac{S_{sunset}}{S_{center}} = \frac{357}{10} \approx 36$$

7) C

Intensity remains constant while the energy of each photon increases means that the number of photons is going to decrease.

8) C

Assume the sculpture is a cube



$A = 6r^2$

$V = r^3$

then each smaller cube has side length $\frac{r}{10}$ and Total surface Area $= 60r^2$

$\frac{60r^2}{6r^2} = 10$ therefore, 1000 buckets

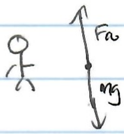
9)

$ma_x = mg\sin 30° - F_f$

$ma_x = mg\sin 30° - \mu_k mg\cos 30°$

$ma_y = mg\cos 30° - F_N$ ~~$\neq$~~

$F_N = mg\cos 30°$



$ma_x \cdot \sin 30° = F_N - mg = +\frac{1}{10}g$

$ma_x = \frac{1}{20}g$

$a_x = + \frac{g}{8}$

$\mu_k = \frac{g\sin 30° - a_x}{g\cos 30°}$

$\frac{\frac{1}{2}g - \frac{g}{8}}{\frac{\sqrt{3}}{2}g}$

$\mu_k = \frac{\sqrt{3}}{4}$

10) 3

According to the equation $PV = nRT$

At 2 : $T_2 = 2T_0$

At 3 : $T_3 = 6T_0$

11) 3

By plugging in numbers into $F_g = \frac{GMm}{r^2}$
you can tell the answer.

12) C

parallel light ray will pass through the focal point of the lens,
Therefore 3 is the focal length.

13) C

The relative velocity V : $\frac{L}{V} = t$

therefore, $(25+V) \cdot t = L$

$(25+V)6 = 300$

$25+V = 50$

$V = 25m/s$

14) E

$\frac{1}{f} = \frac{1}{di} + \frac{1}{do}$

$0 = -(di)^{-2} \cdot di' - (do)^{-2} \cdot do'$ $\qquad di = do$

$do' = di'$ There fore, $di' = 25 \text{ km/h}$

$do' = 25 \text{ km/h}$

relative velocity $= di' + do'$

$= 50 \text{km/h}$

15) D

$PV = nRT$ R and T are constants so the P is proportional to n

By $\frac{m}{\text{Molas mass}}$ $n_C > n_B > n_A$

so $P_C > P_B > P_A$

16) B

$\frac{1}{2}m_1v_1^2 = \frac{1}{2}m_2v_2^2$

$\frac{m_1}{m_2} = \left(\frac{v_2}{v_1}\right)^2$

$\frac{1}{4} = \left(\frac{v_2}{v_1}\right)^2$

$\frac{v_2}{v_1} = \frac{1}{2}$

then, by

$v_{fy}^2 = v_{iy}^2 - 2gh$

$0 = v_{iy}^2 - 2gh$

$2gh_1 = v_{iy}^2$

$2gh_2 = v_{2y}^2$

$\frac{1}{4} = \frac{2gh_2}{2gh_1}$

$\frac{1}{4} = \frac{h_2}{h_1}$

17) D

n air $<$ n glass

when $n_1 > n_2$, the ray is going to get closer to the normal line,
when $n_2 < n_1$, the ray is deflecting from the normal line.

18) B

Frequency of light is not influenced by the refractive rate.

19) C

There is no external force under free fall, and surface tension will make blood into spherical form.

20) C

$t = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$

$t = \frac{100}{\sqrt{1-0.36}}$

$t = 125ns$

21) B

only magnetic field ~~can~~ can produce a circular motion

22) D

This ~~not~~ intuitive that sound cannot propagate without a medium.

23) A

Equation: $\Delta y = \frac{\lambda L}{d}$ If d is decreasing then Δy ~~or~~, the range ~~of~~ where electrons hit increase.

24) E

The pendulum doesn't swing on the ISS

25) B

$L = L_P\sqrt{1-\frac{v^2}{c^2}}$

$L = L_P\sqrt{0.64}$

$L = 0.8 L_B$

$L_B = \frac{5}{4}L$

$L_A = L\sqrt{0.64}$

$L_A = 0.8L = \frac{4}{5}L$

$\frac{L_A}{L_B} = \frac{\frac{4}{5}L}{\frac{5}{4}L}$

$= \frac{16}{25}$