Essay Exam 2, Jay Patel, Classical Physics1 OL01 Professor Van, Huett

Classical Physics I Sum15 V. Huett
Final Exam

Name: Patel, Jay

Essay Questions (10 points each). **Show your work**, partial-credit will be given. **Circle** your answer.

1) An object of mass 5835 kg rests on the flatbed of a truck. It is held in place by metal brackets that can exert a maximum horizontal force of 9120 N. When the truck is traveling 28 m/s, what is the minimum stopping time if the load is not to slide forward into the cab?

Let,

a be the acceleration

d be the stopping distance.

$9120N = 5385 * a$

$a = 1.6935 m/s^2$ eq (1)

Using eq

$v^2 = u^2 + 2*a*d$

$0 = 28^2 - 2ad$

$a = 784/(2d)$

Substituting for a in eq(1)

$784/(2d) <= 1.5 m/s^2$

$S >= 784/3.387$

$\boxed{S >= 231.47m}$ → for the distance.

To find the time,

$a_{max} = \frac{F_{max}}{m} = \frac{9120N}{5835 kg} = 1.563 m/s^2$

$t_{min} = \frac{v_t - v_0}{a_{max}} = \frac{0 - (28m/s)}{-(1.563m/s^2)} = \boxed{17.91s}$

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2) A solid cylinder rolls down an incline plane without slipping. If the center of mass of the cylinder has a linear acceleration of 2.67 m/s^2, what is the angle of the incline to the horizontal?

$ma = mg\sin(\theta) - f$

$\therefore$ f is the frictional force

torque on the cylinder = $I(d\omega/dt) = f * r$

ω = angular velocity

r = radius of cylinder

I = moment of inertia

velocity = $r * \omega$ — formula

Solving for a and f we get $\therefore$ inregards of a & f

$a = g\sin(\theta) / [1 + I/mr^2]$

$f = mg\sin(\theta) / [1 + mr^2/I]$

for a solid cylinder $I = 1/2\, mr^2$.

So, $a = 2g\sin(\theta)/3$

Here, $a = 2.67$ m/s^2

So, $\therefore$ after solving.

$\boxed{\theta = 24.12 \text{ degrees}}$

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3) A rectangular box of negligible mass measures 5.0 m long, 1.0 m wide, and 0.50 m high. How many kilograms of mass can be loaded onto the box before it sinks in a pool of liquid mercury?

Weight of mercury displaced = total weight of box

$5m \times 1m \times 0.5m \times 1360\ kg/m^3$ = total weight of the box

$\therefore$ $\boxed{3400\ kg}$ OR $\boxed{3.4 \times 10^3\ kg}$

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4) A 10.0-m long wire whose total mass is 39.5 grams is under a tension of 577 N. A pulse is sent down the left end of the wire and 29 ms later a second pulse is sent down the right end of the wire. Where do the pulses first meet?

$l = 10.0\,m$

$T = 577N.$

$m = 39.5$ grams.

Speed of the pulse by $v = \sqrt{T/\mu}$

mass per unit $\mu = 0.0395\,kg/10m$

$= 0.00395\,kg/m$

$v = \sqrt{577/0.00395} = 382.2\,m/s$

After 29ms, $382.2 \times 0.029 = 11.0838m$

so A = 10m to right

01.08 from right end

so for B it travels to left at 382.2 m/s

Total distance travel by A in time

$(10-1.08)+d = 8.92+d$

Total distance travel by B in time $= 10-d$

For A → $8.92 + d = 382.2T$

For B → $10 - d = 382.2T$

$8.92 + d = 10 - d$

$2d = 1.08$

$d = \frac{1.08}{2}$

$\boxed{d = 0.54m \text{ from the left end}}$

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5) A stone of mass 2.1 grams is dropped from a height of 0.96 m. If 0.061% of its energy is converted to sound for a duration of 0.143s, how far away can you hear the stone hit the ground? Assume you need at least an intensity of 1.00×10^{-8} W/m^2 to be able to hear the stone hit the ground.

$K = U = mgh = 2.1 * 10^{-3} kg * 9.81 m/s^2 * 0.96 m$

$= \boxed{1.98 * 10^{-2} J}$ ∴ after solving

0.061% of that energy is converted into sound wave energy E.

$E = 6.1 * 10^{-4} * 1.98 * 10^{-2} J$

$= \boxed{1.2 * 10^{-5} J}$ ∴ after solving

Sound energy is released in 0.143s, so the power released into sound at the impact position is

$P_0 = E/t = \frac{1.2 * 10^{-5} J}{0.143 s} = \boxed{8.4 * 10^{-5} W}$

sound intensity will be,

$I = P_0/(2\pi r^2)$

For audibility $I > I_{min} = 1.00 * 10^{-8} W/m^2$

so this will give an upper bound

$r < \sqrt{P_0/(2\pi I_{min})}$

$r < \sqrt{8.4 * 10^{-5} W/(2\pi * 1.00 * 10^{-8} W/m^2)}$ ∴ plugin the values.

$\boxed{r < 36.6 m}$

so, converting into two significant digit answer is $\boxed{37 m}$ → final answer