10 non-original phys problems.
<u>Marking Scheme.</u>

1a. Assume no liquid is boiled / evaporated away
// Assume mass of liquid is the same. } Any 1 (1).

$$E = mc\Delta T$$ (1)

$$1000(0.69)(3600) = 10(c)(50-25)$$

$$c = 9936 \ J\,kg^{-1}\,{}^{\circ}C^{-1}$$

$$c \approx 9940 \ J\,kg^{-1}\,{}^{\circ}C^{-1}$$

b i. The lid should not covered (1)
The heater is not fully immersed in the liquid. } Any 2
The cup is not wrapped with wool. } (2) (1) each

ii. Polystyrene. It is a poor heat conductor, which can help to reduce heat loss by conduction. (1)

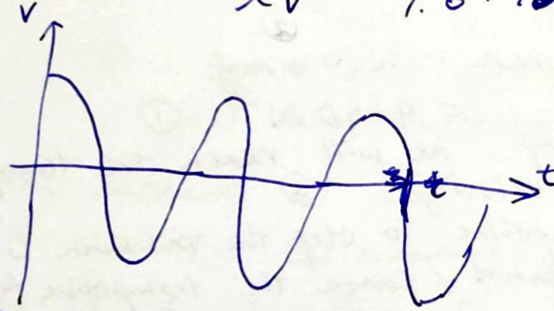
iii. $E = m l_v$

$$(1.6)(1000)(60) = \cancel{(10)}(0.01)(l_v)$$ (1)

$$l_v = 9.6 \cdot 10^6 \ J\,kg^{-1}$$

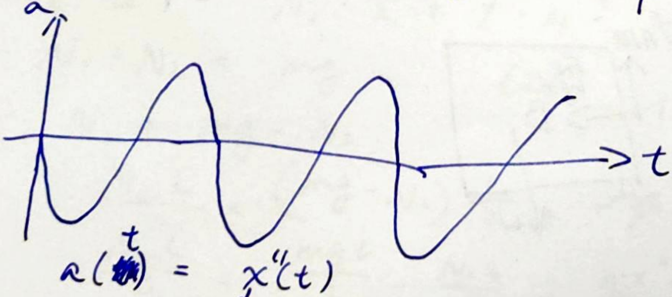
2 i.

(1)



Axis titles required.
labels of time not required.
Amplitude need not be (labeled) correct.

(1)



ii. $a(t) = x''(t)$

$$= \frac{d}{dt}\,\omega A\cos(\omega t)$$

$$= -\omega^2 A\sin(\omega t)$$

$$a(x) = -\omega^2 x$$ (1)

$$\therefore F(x) = m(a(x))$$

$$= -\omega^2 x \cdot m = -m\omega^2 x$$ (1)

b. Max velocity: whenever $x = 0$ (i.e. at equilibrium position) (1)
Max acceleration: whenever $x = A$ (i.e. at max pt or at min pt) (1)

c. No he is incorrect 1
The energy is stored as elastic potential energy in the string 1
Total energy is hence conserved.

3a. $s = ut + \frac{1}{2}at^2$ 1

$12 = s = (0) + \frac{1}{2}(9.81)t^2$

$\therefore t = 1.56s$ 1 $\therefore$ Time taken to reach ground $= 1.56s$

b. $F_{net} = \frac{\Delta p}{\Delta t}$ Take upward as positive.

$v^2 = u^2 + 2as$

$\therefore v^2 = 2(9.81)(12)$

$v = 15.344\ ms^{-1} \approx 15.3\ ms^{-1}$ 1

$F_{net} = \frac{\Delta p}{\Delta t}$

$= \frac{m(0-(-v))}{\Delta t}$ 1

$= +\frac{(115)(15.3)}{0.5}$

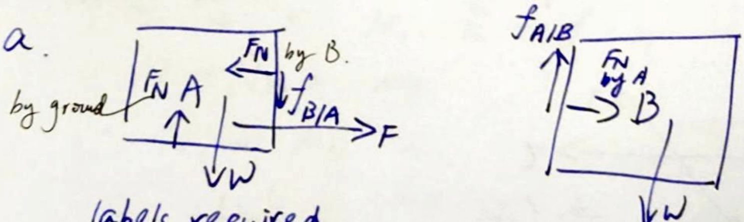
$= 3530\ N$

$\therefore F$ by trampoline on man $= 3530 + mg$

$= 4660\ N$ 1

c. If the man is higher up, he will reach the trampoline with an even larger velocity 1
The force exerted by trampoline to stop the fat man will be increased, leading to injuries / cause the trampoline to break 1

4a.



labels required.

b. $f = 0.8(F_N)$

Note that F_N by A on B is the only force in horizontal direction

$\# \hat{a}_B = a_{system}$.

$\therefore m_B a_B = F_N$ by A 1

$(1)(a_{system}) = F_N$ by A

$0.8(F_N \text{ by } A) = m_b g$

F_N by A $= 12.3\ N$ $\therefore a_{system} = 12.3\ ms^{-2}$ 1

$F = m_{system} a_{system} = (12.3)(4) = 49.1N$ 1

c. $S = ut + \frac{1}{2}at^2$

$\therefore \Delta S = \frac{1}{2}(12.3)(\cancel{4}10^2)$

$\Delta S = 613 m$ ①

$\therefore W = F \cdot \Delta S$

$= 30100 N$

$\therefore P = \frac{W}{10} = 3010 W$ //

①

d. It will be increased ①

Friction opposes motion of the system, thus a of system is reduced since $F_{net} = F - f < F$ ①
in horizontal

$\therefore a_{system} = \frac{F_{net}}{m_{sys}}$ $\therefore F_{N \text{ by } A \text{ on } B} = \frac{F_{net}}{m_{sys}} \cdot m_B$

$\because 0.8 F_{N \text{ by } A \text{ on } B} = m_B g$

$\Leftrightarrow$ ~~$F_{N \text{ by}}$~~ $0.8 F_{net} = m_{sys} g$

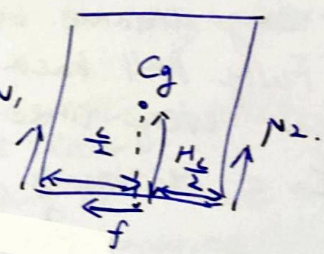
$\therefore$ Since F_{net} is equal to before

if B does not fall down

$\therefore$ F must increase

5a. Take moment at CG.

ACW moment = CW moment



$\Rightarrow$ $N_2 \cdot \frac{L}{2} = N_1 \cdot \frac{L}{2} + f \cdot H$ ... (1)

$N_1 + N_2 = mg$ ... (2) — 1M.

$\therefore N_1 = mg - N_2$.

$\frac{N_2 L}{2} = (mg - N_2)\frac{L}{2} + \frac{mv^2}{r} \cdot H$ — 1M.

$\frac{N_2 L}{2} = \frac{mgL}{2} - \frac{N_2 L}{2} + \frac{mv^2 H}{r}$

$N_2 L = \frac{mgL}{2} + \frac{mv^2 H}{r}$

$N_2 L = m\left(\frac{gL}{2} + \frac{Hv^2}{r}\right)$

$N_2 = m\left(\frac{g}{2} + \frac{Hv^2}{Lr}\right)$ — 1M.

$N_1 = mg - N_2$

$N_1 = m\left(\frac{g}{2} - \frac{Hv^2}{Lr}\right)$ — 1M.

6a. Work done by ME $\rightarrow$ Elastic potential energy (in spring) - 1M

$\rightarrow$ KE (of the toy car) - 1M.

each correct energy form 1M.

6b. • Put / Assemble a long frictionless straight track with the pieces ①

• Mark a start point and an end point and measure the distance between the 2 points (Δs) with the ruler ①

• Pull back the toy car and release it from one end

• Time the amount of time need for the toy car to travel from start point to end point (Δt) with a stopwatch ①

• Repeat the steps several times to obtain a few values of Δt. Then take the average of the results. ①.

• The U stored in spring can be found as follows:

$$U = KE$$

$$\therefore U = \frac{1}{2} m v_c^2$$

$$U = \frac{1}{2} m \left(\frac{\Delta s}{\Delta t_{avg}}\right)^2$$

①

Precaution

• Ample from between pt at which toy car is released from and start point

• Long distance between start and finishing point.

• Fully pull back and tighten up the spring of the toy car every time

① Any one.

7a. In a stationary wave with n loops,

$$\frac{\lambda}{2} \cdot n = L.$$

$$\therefore \frac{v}{2f} \cdot n = L$$

$$f = \frac{nv}{2L} \quad ①$$

$$\therefore 24 = \frac{n(v)}{2L} \quad \dots (1) \qquad 28 = \frac{(n+1)v}{2L} \quad \dots (2)$$

(2) - (1)

$$4 = \frac{v}{2L}$$

① for correct elimination step.

$$\therefore v = 12 \text{ ms}^{-1}$$

$$\therefore f_0 = \frac{(1)v}{2L} = 4 \text{ Hz}$$

① For answer.

7b. · The incident travelling wave is reflected at the fixed end ①
· The reflected wave superimpose on the incident wave to create a Stationary wave ①

7c. · The vibration of the particles in the string causes nearby air particles to also vibrate ①
· The vibration of air particles generate sound waves with the same frequency (which is within human audible range) ①

7d. $v = \sqrt{\frac{T}{\mu}}$

· Since more mass is added, v of wave in string increases ①
· By $f_0 = \frac{v}{2L}$, $\therefore f_0$ will be increased ①

8a. Ultrasound are sound ~~waves~~ waves with frequency above 20 kHz // Above human audible range ①

b.
$$\frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$ ①
$$\frac{\sin 10^\circ}{\sin r} = \frac{340}{1500}$$
$$r = 50.0^\circ$$ ①

c. A small angle of incidence will lead to a large angle of refraction of the ultrasound waves ①
/ Bent from original direction.
Since one assumes ultrasound waves to travel straight and does not know that the waves are bent and undergone refraction, it results in both improper positioning or errors in brightness of echoes in ~~images~~. ultrasound images. ①
Reference : HKDSE 2022 P2 Q4a iii.

d.
$$\Delta s = \frac{1}{2} v \Delta t$$ ①
$$\therefore \Delta s = \frac{1}{2}(1500)(50 \cdot 10^{-6})$$
$$\Delta s = 3.75 \text{ cm}$$ ①
$\therefore$ Thickness of skin & fat layer = 3.75 cm.

9a. Coherent sources refers to sources emitting waves of the same frequency / with constant phase relationship ①
b. Q is a point of constructive interference ①
This is because path difference at Q is equal to $m\lambda$ $(m \in \mathbb{Z})$ ①
///

c. $\Delta_Q = \lambda$

$\therefore \lambda = \sqrt{4^2+4^2} - \sqrt{4^2+2^2}$

$\lambda = 1.18m$ (1)

$\therefore f = \frac{v}{\lambda}$

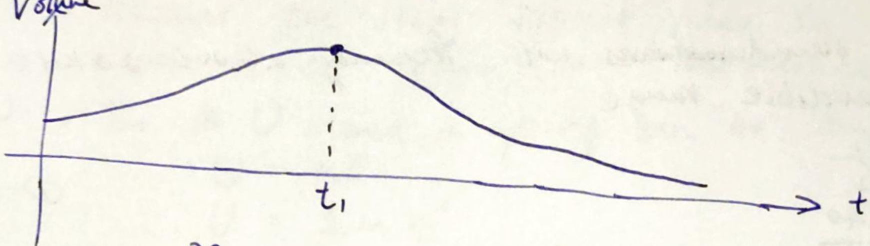
$f = 287$ Hz (1)

d. $\lambda' = \frac{v}{f'} = \frac{v}{\frac{1}{2}f} = 2\lambda$ (1)

$\therefore \Delta_Q = \lambda = \frac{1}{2}\lambda'$ (1)

$\therefore$ Destructive interference occurs at Q, so a soft sound is heard at Q

e.



(1)

Correct shape (1)
(only no straight line)

Correct position t_1 (1)
(Max pt of curve)

f. $\Delta y = \frac{D\lambda}{a}$ assumes $D \gg a$. / $a \gg \lambda$.

However, in our case, D is comparable to a / a is comparable to λ (1)

$\therefore$ The assumption does not hold so $\Delta y = \frac{D\lambda}{a}$ does not hold.

10a. Diffraction occurs when light passes through the single slit (1)
→ Larger bright area on the screen

Since light is spread across larger area, the intensity (brightness) of the ~~light~~ light on the screen is lower. (1)

b i. Angle of 2^{nd} order is larger than that of 1^{st} order
$\therefore$ Percentage error due to uncertainty in measuring instruments can be reduced (1)

ii. $d \sin\theta = m\lambda$ $\quad$ $d = \frac{1 \cdot 10^{-3}}{500} = 2\mu m$ (1)

$\therefore \lambda = 449$ nm

iii. $\frac{m\lambda}{d} = \sin\theta \leq 1$

$\therefore m \leq \frac{d}{\lambda}$

$m \leq 4.45$

$\therefore$ Max order maximum that can be seen is 4^{th} order (1)

$\therefore$ 9 bright spots can be observed (1).

iv. Measure diffraction ~~g~~ angle on both sides of the central maximum, then ~~the~~ take the average of the 2 angles measured.

c. Angular range of 2^{nd} order (visible light)

$d\sin\theta_v = m\lambda$

$\sin\theta_v = \dfrac{2(400\cdot10^{-9})}{2\cdot10^{-6}}$

$\theta_v = 23.6°$

$d\sin\theta_r = m\lambda$

$\sin\theta_r = \dfrac{2(700\cdot10^{-9})}{2\cdot10^{-6}}$

$\theta_r = 44.4°$

$\therefore$ Angular range of 2^{nd} order = 23.6° - 44.4°

Angular range of 3^{rd} order.

$\sin\theta_v = \dfrac{m\lambda}{d}$

$\theta_v = 36.9°$

$\sin\theta r = \dfrac{m\lambda}{d}$

$\sin\theta r = 1.05$

$\therefore \theta r$ does not exist

$\therefore$ Angular range of 3^{rd} order : Beyond 36.9°

Any one (1)

$\therefore$ The 2 orders coincide at 36.9° - 44.4°

Accept other means of proof (1)

e.g. $\sin\theta_v$ of 3^{rd} order < $\sin\theta_r$ of 2^{nd} order with appropriate calculations.