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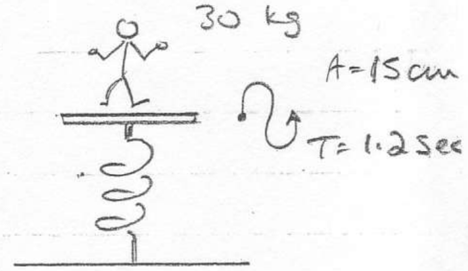
S.H.M - questions /2

A - Physics
$g_{Earth} = 10$ N/kg
$g_{moon} = 1.6$ N/kg

B. SHM + springs

1. A child bounces on a playground spring.



What is ... (a) frequency? (2)
(b) max. velocity, and where? (3)
(c) max. acceleration, and where? (3)
(d) spring stiffness? (2)
(e) Sketch graphs of displacement, velocity and acceleration against time. (4 + 2 + 2)
(f) what's the maximum K.E of the child; and where does it occur? (3)
(g) what's the maximum potential energy stored in the spring and where does it occur? (3)
(h) what's the minimum force the platform exerts on the child, and where does it occur? (2)
(i) The amplitude of SHM increases until the child just loses contact with the platform. Why does this happen, and where does it occur in the cycle? (3)
(j) What is the maximum amplitude for the child to stay in contact? (2)

[31]

2. A spring, of unstretched length 8.5 cm, has a 600g mass hung from it, and the new length is 18.2 cm.
(a) what is the spring constant? (2)
(b) what will be the frequency of oscillation of a <u>300g</u> mass? (2)
(c) what will be the maximum spring tension? (2)
H (d) what will be the time period of oscillation of a <u>600g</u> mass on a pendulum of ... (i) 2 springs joined end to end? (3)
(ii) 2 springs in parallel? (3)

H -ish. 3. A mass hung on a spring stretches it by 6 cm. What is the time period when it oscillates as a spring pendulum? (4)

HH 4. Show how you can work out that the time period of a simple pendulum must always be $T = 2\pi\sqrt{\frac{l}{g}}$
(hint: displacement is x (m), from centre of swing.)

TM
3.98 + 11.02

SHM - 2 Answers - version 2 A - Physics

B 1(a) $f = 1/T = \underline{0.833\ Hz}$ (2) (b) $V_{max} = \omega A$ (1) $= \underline{0.785}$ (1) m/s at centre, $x = 0$ (1) !! (3)

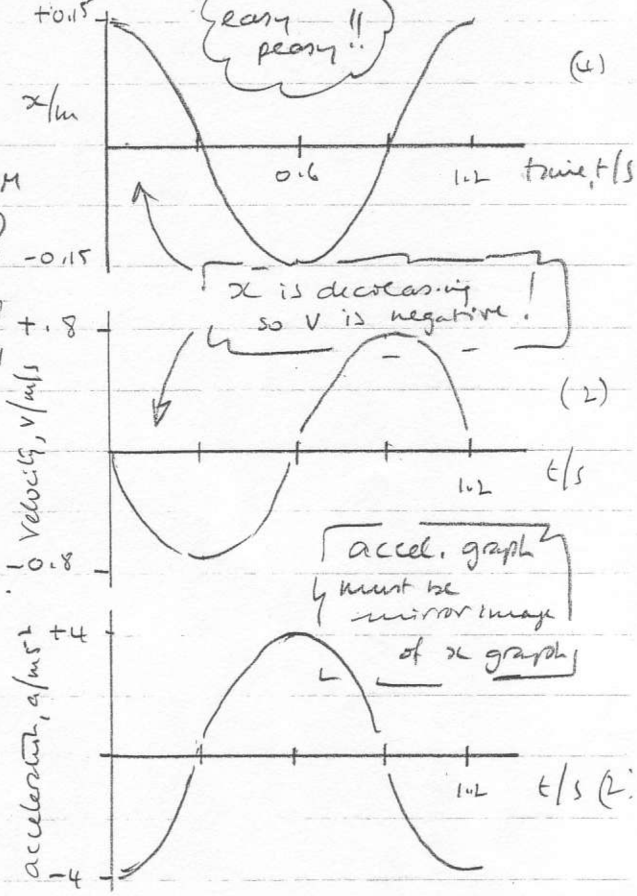
(c) $a_{max} = \omega^2 A$ (1) $= \underline{4.11}$ (1) m/s at top + bottom (1) of SHM (3)

(d) Use $T = 2\pi\sqrt{m/k} \Rightarrow \sqrt{k} = \frac{2\pi\sqrt{m}}{T} = \underline{28.7} \Rightarrow k = \underline{822\ N/m}$ (2)

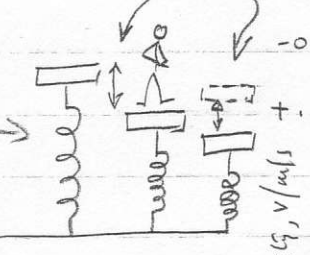
(e) See $\Rightarrow$ (8)

(f) $KE_{max} = \frac{1}{2} m v_{max}^2$ (1) $= \underline{9.24}$ (1) J

at the centre $x = 0$ (1) (3)



(g) static compression = x m SHM



no child
no compression
no stored energy

with child still... $mg = kx$

so $x = mg/k = 30 \times 10 / 822 = 0.365$ m

And the amplitude = 0.15 m

so max compression^c = 0.37 + 0.15 = 0.52 m.

E stored $= \frac{1}{2} F c = \frac{1}{2} k c^2 = \underline{111\ J}$

(h) Min. force ... at top of bounce !

(i) Lose contact when platform

accelerates down at $a = 10\ m/s^2$ (1)

= accel. due to gravity - at the top of the bounce. (1) (2)

(j) For this $a_{max} = 10\ m/s^2 = \omega^2 A_{max}$ (1) $\Rightarrow A_{max} = \frac{10}{\omega^2} = \frac{10}{(2\pi f)^2} = 0.365$ m. (1) (2)

2. (a) x spring $= 18.2 - 8.5 = 9.7$ cm $= \underline{9.7 \times 10^{-2}}$ (1) m. $k = F/x = 6/9.7\times10^{-2} = \underline{61.8\ Nm^{-1}}$ (1) /

(b) $T = 2\pi\sqrt{m/k} = 2\pi\sqrt{\frac{0.3}{61.8}}$ (1) $= \underline{0.44\ s} \Rightarrow f = 1/T = \underline{2.3}$ (1) Hz /2

(c) Tmax at the bottom of the bounce ! /1

(d) (i)  $k = \frac{1}{2} \times 62 = 31$ N/m (1) So $T = 2\pi\sqrt{m/k} = \underline{0.87\ s}$ (1)

(ii) $k = 2 \times 62 = 124$ (1) N/m so $T = \underline{0.44\ s}$ (1) /4 [9] !!

3. $F = mg = kx \Rightarrow m/k = x/g$ (1) $= \frac{0.06}{10} = 0.006$ (1) !

$T = 2\pi\sqrt{m/k} = 2\pi\sqrt{0.006} = \underline{0.49}$ (1) seconds ! [3]

3.98

+ 12.02

① 1 /22 2 /9 3 /3