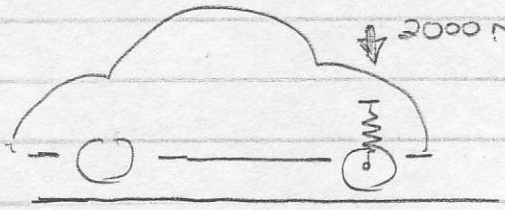
S.H.M. Topic Test

A2 Physics

$g_{Earth} = 10\ N/kg$

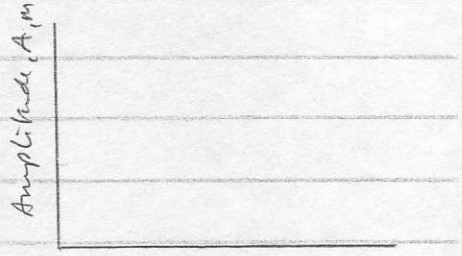
1. A car is suspended on 4 springs, one on each wheel - so the total car weight of 8000 N is divided equally with 2000 N on the spring at each wheel - no damping system has been fitted.



(a) When the car is lifted off the ground each spring extends by 20 cm. Show that the spring constant is 1×10^4 N/m. (2

b) When the corner of the car is pushed down & let go it oscillates up and down - calculate the frequency of oscillation (4

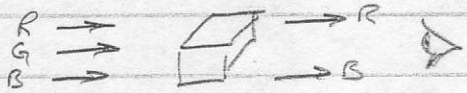
c) The corner of the car is pushed down 0.1m and let go - no damping system yet fitted. Sketch a graph of amplitude against time, - label this — ① (2)



d) Dampers are fitted and set to light damping. Sketch the amplitude - time graph on the same axes — label it — ② (1).

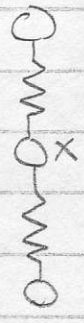
e) The dampers are now set to critical damping - sketch the new curve and label it - ③ (1)

2. A newly discovered crystal lets through red and blue light but strongly absorbs green - $\lambda = 450$ nm.



a) Calculate the frequency of the green light. ($V_{light} = 3 \times 10^8$ m/s) (2)

b) The diagram shows one atom (X) in the crystal. Calculate the spring constant of the atomic bonds in the crystal. (atom x has mass of 8×10^{-26} kg) (4)



c) Explain how the crystal absorbs green light. (3)

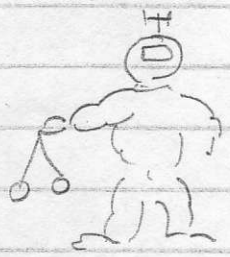
c) When green light is shone on the crystal, atom X oscillates with an Amplitude of 2×10^{-10} m.

d) Sketch a graph to show how the P.E. and K.E vary as it oscillates. (3)

e) Sketch a graph to show how the amplitude varies as the colour is changed from red, through green, to blue. (3)

f) Calculate the maximum velocity of atom X.
Where does this occur? (3)

3 An astronaut lands on planet Z and gets out her pendulum, length 40 cm, and finds the time of swing is exactly 1.0 sec.



a) What is the gravity field strength of the planet? (3)

The pendulum bob has a maximum displacement of 5 cm.

b) What is it's maximum velocity (2)

c) What is its maximum acceleration? (2)

d) What is the displacement of the bob .... (i) 0.25 sec
(ii) 0.4 sec
after leaving the extreme end of the oscillation? (3)

Marks Q... 1 /10 2 /19 3 /10

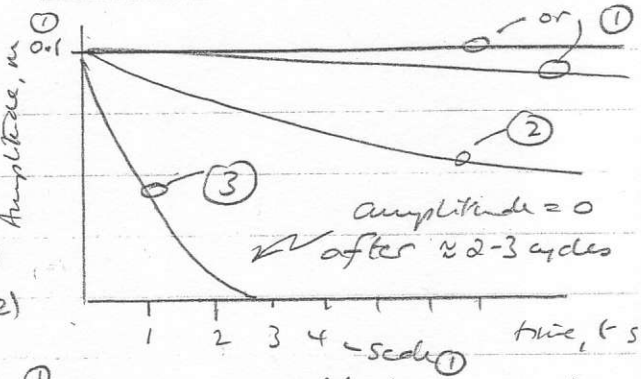
SHM Test → Answers !

A2 Physics

1. (a) $F = kx \Rightarrow k = f/x = 2000/20\times10^{-2} = 10\,000$ N/m (2)

(b) use $T = 2\pi\sqrt{m/k} = 2\pi\sqrt{200/10000} = 0.889$ s $\Rightarrow f = 1.13$ Hz (4)

(c) (d) & (e) (out of 5)



2. (a) use $v = f\lambda \Rightarrow f = v/\lambda = \frac{3\times10^8}{450\times10^{-9}}$

$= 6.67\times10^{14}$ Hz (2)

(b) use $T = 2\pi\sqrt{m/k}$

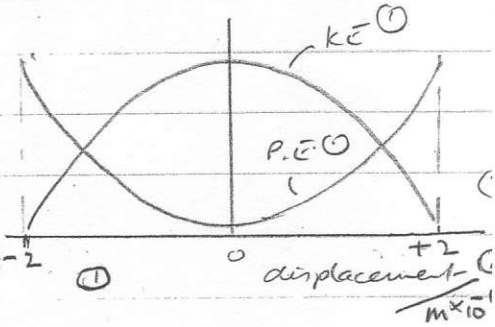
So $T^2 = 4\pi^2 m/k \Rightarrow k = 4\pi^2 m/T^2 = 4\pi^2 \times 8\times10^{-26}/(1.5\times10^{-15})^2$

$= 1.4\times10^6$ N/m

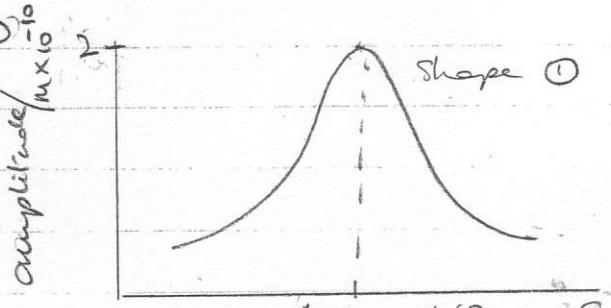
$T = 1/f = 1.5\times10^{-15}$ s (5)

(c) green light has the same frequency as the natural frequency of oscillation of atom x so x resonates (3)

(d)



(e)



red green blue (3)

(f) $V_{max} = 2\pi f A = 2\pi \times 6.67\times10^{14} \times 2\times10^{-10} = 8.38\times10^5$ m/s (3)

Total /39.

3/10

3. a) Use $T = 2\pi\sqrt{l/g} \Rightarrow T^2 = 4\pi^2 l/g \Rightarrow g = 4\pi^2 l/T^2$

$= 4\pi^2 \times 0.4/1.2$

$= 15.8$ N/kg (3)

2/10

b) $V_{max} = 2\pi f A = 2\times\pi\times1\times0.05$

$= 0.314$ m/s (2)

1/10

c) $a = -\omega^2 x = -(2\pi f)^2 x$ so $a_{max} = (2\pi f)^2 A$

$a_{max} = (2\pi\times1)^2 \times 0.05 = 1.97$ m/s^2 (2)

d) use $x = A\cos 2\pi f t$ (1) for $t = 0.25$ sec $x = 0.05\times\cos(2\pi\times1\times0.25)$

radians!

$= 0$ think!

(2) for $t = 0.4$ sec $x = 0.05\times\cos(2\pi\times0.4)$

$= -0.04$ m (4)

↳ on the other side.

Marks:

8/N

10.01 and Jan '04