AS-2008 Q4

4. When a loud sharp sound is played in a room, the sound reverberates around the room until it gradually dies away. The reverberation time T for a room of volume V having surface area A is given by the expression

$$T = \frac{kV}{\alpha A}$$

Where k is a constant and α is a measure of the mean sound absorption by the surfaces.
If two rooms of identical shape and with walls of the same material, are tested for reverberation time, then for a room which is ten time longer, by what factor will the reverberation time be greater than for the smaller room?

A. 1000

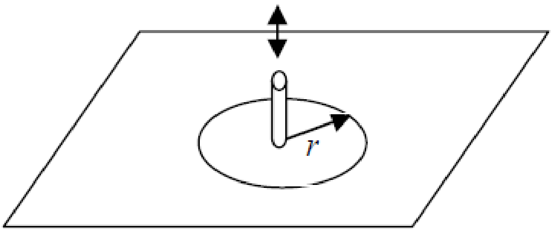
B. 100

C. 10

D. it depends upon the other dimensions of the rooms

AS-2009 Q9

9. A wave on the surface of a liquid has amplitude A when it is emitted from the source of the wave, which is a dipper moving up and down in the liquid. The wave spreads out over the plane surface of the liquid, forming a circle of radius r which increases at the speed of the wave.
The energy of the wave is spread out over the circumference of the circle, so that as the circumference increases, the energy in a unit length of the circumference decreases as $1/r$. If the energy of the wave is proportional to the square of its amplitude A, then what is the new amplitude of the wave when r increases by four times from its previous value?



A. $A/2$ B. $A/4$ C. $A/8$ D. $A/16$

AS-2007 Q9

A mass M is attached to the end of a horizontal spring. The mass is pulled to the right, 8 cm from its rest position. It is then released so that the mass oscillates to the left and right, with the system gradually losing energy over many cycles.

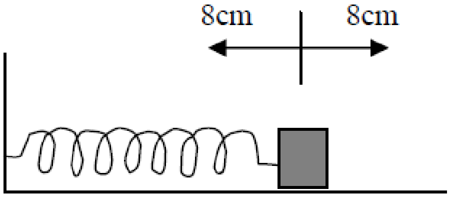


fig. 7

a) State the energy changes that take place over one complete cycle as the mass moves to the left and then back to the right.

____

____

______________________________ [2]

b) The energy stored in a stretched spring is proportional to the square of the extension of the spring. If after some time, the amplitude of the oscillation is reduced to 1 cm, what fraction of the initial energy has been lost? Show your working.

____

____

______________________________ [2]

c) We will need to use a concept that you have met in radioactivity. State what is meant by the half-life of a radioactive substance.

____

____

______________________________ [1]

d) Now we shall apply this concept to the loss of energy from the oscillating system. The amplitude decays away in the same manner as radioactive decay (exponentially). How many half-lives have passed for the amplitude to reduce to 1 cm?

____

____ [2]

e) The period of oscillation does not depend upon the amplitude of the oscillation, being the same for both large and small amplitudes. The period of oscillation is 0.5 seconds. The half-life for the amplitude loss is 5 seconds. How many oscillations have occurred by the time the amplitude has dropped down to 1cm?

____

____ [2]

f) The energy is also dissipated away exponentially with time. Using your answer to part (b) for the energy lost, how many energy loss half-lives have passed when the amplitude has reduced to 1 cm?

____

____

____ [2]

/11

AS-2010 Q13

13. Waves on the open sea, known as gravity waves in order to distinguish them from ripples on a pond, have a speed v that depends upon the wavelength λ and the depth of the sea, h.

In **deep water**, $h >> \lambda$ and the speed v is independent of h, but does depend upon λ.

$$v = \sqrt{\frac{g\lambda}{2\pi}}$$

In **shallow water**, $h << \lambda$, and the speed v is independent of λ, but does depend upon h.

$$v = \sqrt{gh}$$

a) For a ship in **deep water**, the motion of the ship creates a wave such that the faster the speed the longer the wavelength. At some speed, known as the hull speed, v_{hull}, the wavelength becomes equal to the length of the ship L, as shown below. It is then very difficult for the ship to increase its speed as it has to climb the wave at the bow.

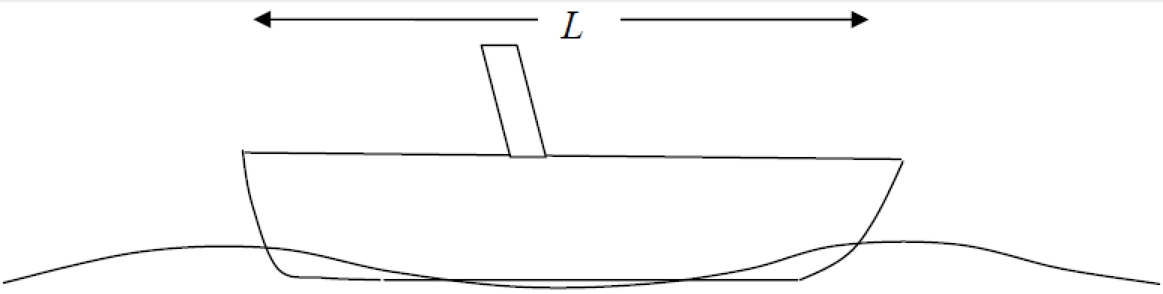


Figure 1

Show that $v_{hull} = 1.2\, L^{½}$

____

____ [1]

b) The formula $v_{hull} = 1.2\, L^{½}$ only works when L is measured in metres. Explain why.

____

____ [2]

AS-2010 Q13 (continued)

c) Show that for deep water waves, $v = \frac{g}{2\pi}T$ where T is the period of the wave.

____

____ [1]

d) A Tsunami (a wave produced as the result of an earthquake) on the ocean has an immense wavelength of 80 km (so the **shallow water** situation applies). Calculate the speed of the wave when the depth of the ocean is 4.7 km, and also when it enters the coastal shallows where the depth is 10 m.

____

____

____

____ [2]

e) The power P associated with a Tsunami wave progressing across the ocean is proportional to the speed of the wave, v (the speed of energy flow), and the square of the amplitude A. The power flowing past a point is constant (otherwise energy would accumulate). Show that for the Tsunami, A is proportional to $h^{-1/4}$.

____

____

____ [2]

f) If the amplitude of the wave is 35 cm on the open ocean where the depth is 4.7 km, calculate the amplitude of the wave when the depth of the water is 10 metres.

____

____ [1]

AS-2010 Q13 (continued)

g) If the distant from the source of the Tsunami is only a few thousand kilometres then the Earth can be considered as a flat surface. However, if the distance from the source is very great then the curvature of the surface of the Earth will focus the waves. The intensity of the wave varies as $\dfrac{1}{\sin\left(\dfrac{r}{R}\right)}$ where r is the distance from the source and R is the radius of the Earth. At what distance from the source will the wave intensity begin to increase due to focusing?

$$R = 6{,}400 \text{ km}$$

Note that in $\sin(r/R)$ the term r/R will give the angle in radians.

____

____

____ [2]

/11

AS-2012 Q13

Two pendulums shown in figure 4 below have equal masses at the end of light straight rods, but one pendulum (of length 2ℓ) is twice the length of the other (of length ℓ).

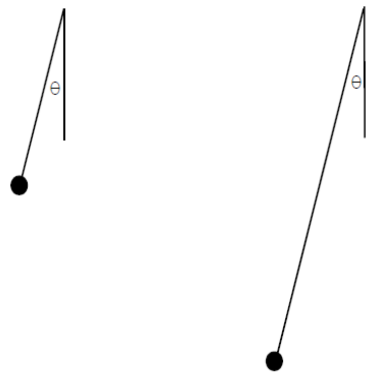


Figure 4.

a) When they are swung through the same initial angle θ and released, which of them has the greater energy in its swing? Give a reason for your answer.

____

____ [2]

b) Each pendulum is released from a horizontal position where the mass at the end is level with the support. The speed at the bottom of the swing for the long pendulum is v_L and the speed at the bottom of the swing for the short pendulum is v_S. By considering the potential and kinetic energy of each pendulum, what is the ratio $\frac{v_L}{v_S}$?

____

____

____ [2]

c) If the short pendulum is released from a horizontal position again, and achieves speed v_S at the bottom of the swing, from what angle θ should the longer pendulum be released so that it reaches the same speed of v_S at the bottom of its swing?

____

____

____ [2]

/6