West Australian Test Papers

PHYSICS

Year 12

2007

SOLUTION BOOKLET

&

MARKING GUIDE

Markers should note that the solutions presented here are skeletal answers and should be used as a guide only.

Alternate answers used by students may be perfectly acceptable and discretion should be used.

Section A: Short Answers

1. Key idea is that a pulse is emitted and the time taken for the pulse to be reflected is measured and the formula: distance = speed x time is used.
Distance calculated needs to be halved to find the depth

$$1.53 \times 10^{3} = \frac{2D}{85 \times 10^{-3}} \qquad D = 65\text{m}$$

2.

$$g(\text{Neptune}) = \frac{GM}{r^2} = \frac{6.67 \times 10^{-11} \times 17 \times 5.98 \times 10^{24}}{\left(2.47 \times 10^{7}\right)^2} = 11.1\,\text{m s}^{-2}$$

3. Key idea is that the **vase B** has the lower Centre of Gravity. Therefore **B** would require a greater angle before its Centre of Gravity was over the pivot point and before it tipped over.

4. (a)

$$I = \frac{400 \times 10^{-3}}{3 \times 60 \times 4} = 5.55 \times 10^{-4}\ \text{W.m}^{-2}$$

(b) Determine the sound intensity at this point.

$$\text{dB} = 10 \log_{10} \frac{5.54 \times 10^{-4}}{10^{-12}} = 87.4\,\text{dB}$$

5. (a)

$$F(\text{max}) = \frac{mv^2}{r} + mg \qquad v = 30\ \text{m s}^{-1}$$

$$= \frac{75 \times 900}{60} + 75 \times 9.8$$

$$= 1125 + 735 = 1860\ \text{N}$$

(b) At the <u>bottom</u> of the loop.

6. (a) Resolving vertically 0.8 = ½9.8 t^2 so t = 0.404 s

(b) Distance = 0.404 x 5 = 2.02 m

7. (a) $P_p = P_s$ Increasing voltage means a decrease in current as $P_{LOSS} = I^2 R$.
This reduces losses. Safety: cannot have separation of active and neutral as large as in the high voltage situation.

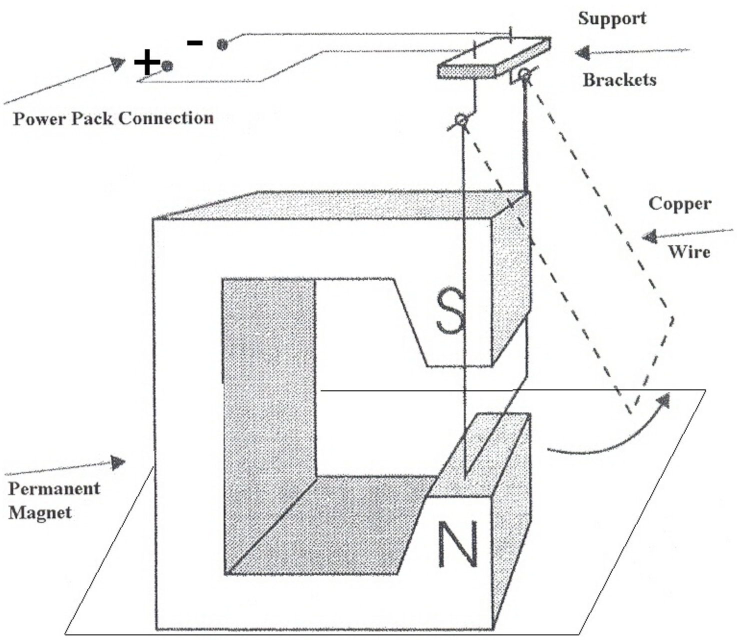
(b) Not needed: current through wire is reduced considerably as is its length so line loss is not as significant.

8. Key idea is destructive interference, path difference LS1 to B and LS2 to B is integer number of **half wavelengths.**

9. (a) **Lenz's law**, the disc cuts the magnetic field from the permanent magnet and has a current induced in it . This induced current flows in such a direction that the field it produces **opposes** the existing field thus providing an opposing force causing the car to slow down.

(b) The E_K of the car is converted to electrical energy in the disc. This is then converted to heat in the disc.

10. (a)



(b) The wire is carrying a current and therefore has its own magnetic field. This field interacts with the permanent magnet's field creating an equal and opposite force on the magnet and the wire. The mass and friction of the magnet on the surface stops it moving but the wire is free to move. The direction of the movement is described by the appropriate hand rule.

11. Torque = n ℓ b I B

$$= 75 \times 20 \times 10^{-3} \times 40 \times 10^{-3} \times 0.08 \times 50 \times 10^{-3} = 2.40 \times 10^{-4} \text{ Nm}$$

12. (a) Clockwise circular path.

(b) $$r = \frac{mv}{Bq} = \frac{9.11 \times 10^{-31} \times 3 \times 10^{6}}{2 \times 10^{-5} \times 1.6 \times 10^{-19}} = 0.85\,\text{m}$$

(c) anti clockwise, bigger radius.

13. (a) E = hf

Energy = $6.64 \times 10^{-34} \times 10^{18} = 6.6 \times 10^{-16}$ J (Range 6×10^{-15} to 6×10^{-17})

(b) Number of photons = $\dfrac{4 \times 10^{-3}}{6 \times 10^{-16}} = 6.6 \times 10^{12}$ (allow range 6.6×10^{11} to 6.6×10^{13})

14. (a) Ground state is E(-5.12) and the first excited state is E(-3.01) eV. (1 mark)

(b) $\Delta E = h \times 525 \times 10^{12} = 3.5 \times 10^{-19}$ Joules = 2.17 eV.
Transition n = 1 ⇒ Ground state since ΔE = 2.11 eV.
(Actual frequency = 508×10^{12} Hz.)

15. Equation (b) is correct.

$$T_1 \cos\theta = T_2 \quad \text{and} \quad T_1 \sin\theta = W$$

$$T_1 = \frac{W}{\sin\theta} \quad \text{so} \quad \frac{W}{\sin\theta}\cos\theta = T_2$$

$$W\cos\theta = T_2 \sin\theta$$

Section B

1. (a) Force up = Force down (resolve vertically)

170 + 250 = 40 x 9.8 + M

M= 28 N (3)

(b) Take moments about A,

$$10 \times 9.8 \times 2 + 28 \times (4) = 250 \times (4 - y)$$

$$784 + 112 = 1000 - 250\,y$$

$$250\,y = 104$$ (4)

$$y = 0.42\,\text{m}$$

(c) $\text{Y.M.} = \text{Gradient} = \dfrac{\text{Stress}}{\text{Strain}} = \dfrac{12 \times 10^{6}}{6 \times 10^{-5}} = 2 \times 10^{11}\ \text{N m}^{-2}$ (2)

(d) $\text{Stress} = \dfrac{170}{2 \times 10^{-4}} = 8.5 \times 10^{5}\ \text{N m}^{-2}$ (2)

(e) Energy stored per m^3 in the wire whilst under tension. (2)

2. (a)

$$u_h = u\cos 40^o$$
$$= 32\cos 40^o = 24.5\,m.s^{-1}$$ (2)

(b)

$$u_v = u\sin 40^o$$
$$= 32\sin 40^o = 20.57\,m.s^{-1}$$ (2)

(c) Resolve vertically, (down +ve)

$$s = u\,t + \frac{1}{2}a\,t^2$$
$$0 = -20.57\,t + 4.9\,t^2 \qquad \text{Time} = 4.2\,s$$ (3)

(d) $s_h = 4.2 \times 24.5 = 103$ m (2)

(e) When s_h = 40 m then t is,

$$t = \frac{40}{24.5} = 1.63\,s$$

Now find s_v at time = 1.63s

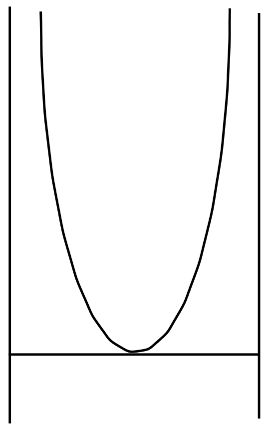
$$s_v = -20.6 \times 1.63 + 4.9 \times (1.63)^2$$
$$= -33.5 + 13.02 \qquad = -20.5\,m$$

Yes, it will clear the tree. (4)

3. (a) Key idea is that you have variable frequency f_v and a fixed natural frequency f_o and when these frequencies are the same ie $f_v = f_o$ then resonance occurs. It is an example of constructive interference between two waves travelling in opposite directions 180^0 out of phase in the same medium. (2)

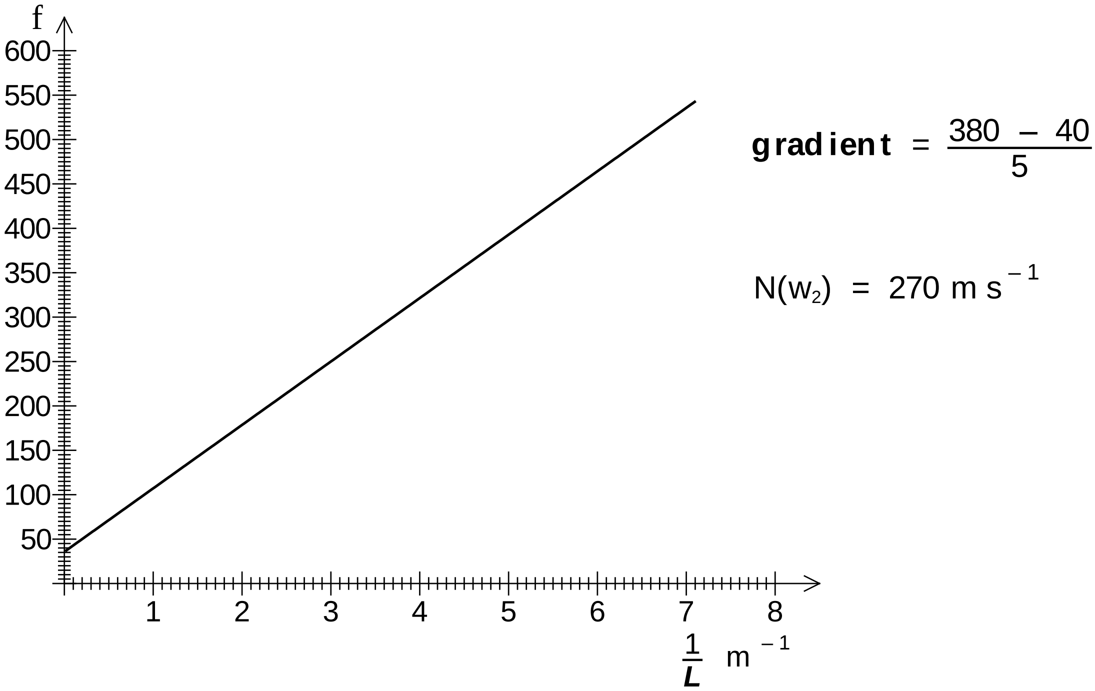
(b) Amplitude increases and therefore a **loud** sound is heard. (2)

(c) Draw the displacement standing wave pattern for the fundamental. (2)



Frequency (Hz)	Length of tube (mm)	$\frac{1}{\text{Length}}(m^{-1})$
530	140	7.1
400	195	5.1
300	270	3.7
250	330	3.0
200	455	2.2
150	665	1.5

(d)



$v = f\lambda$

$v = f\,4L$ where L is the length $\lambda = 4L$ for the fundamental

$f = \frac{v}{4L}$ so if plot frequency against $\frac{1}{\text{Length}}$ then gradient is $\frac{\text{velocity}}{4}$

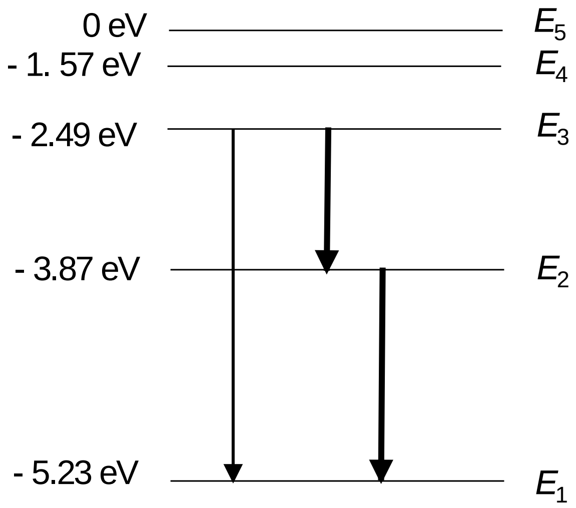
As $y = mx$

$\text{Gradient} = \frac{340}{5} = 68 = \frac{\text{velocity}}{4}$

Velocity of sound in CO_2 = 277 ms^{-1} (5)

(e) Students should demonstrate they understand the standing wave extends outside the dimensions of the tube and an "end correction" should be included.
No details needed. (2)

4. (a)



(3)

(b) E_3-E_1 = h.f should identify this transition as the only one to consider

$$f = \frac{(5.23 - 2.49) \times 1.6 \times 10^{-19}}{6.64 \times 10^{-34}}$$

$$= 6.60 \times 10^{14} \text{ Hz}$$ (3)

(c) Border of visible / infra red via data sheet (1)

(d)
key ideas

- Electrons are excited by thermal or collisions to a higher allowed energy level.
- Return to the ground state via a few possible decays all of which have an energy associated with them.
- These allowed transitions have different energies, frequencies (and colours) and are unique to the element / compound.
- Spectroscopy is a powerful tool in identification of unknown compounds since the spectra are **unique.** (4)

5. (a)

$$F = BI\ell = mg$$

$$\text{emf} = B\ell v = IR$$

$$mg = \frac{B^2 \ell^2 v}{R}$$ (5)

$$B^2 = \frac{0.15 \times 9.8 \times 0.75}{(1.5)^2 \times 2} = 0.245$$

$$B = 0.495\,\text{T}$$

(b) Key idea that there is an induced current in the wire and this results in magnetic force/ field which acts in such a direction as to make the rectangle slow down. Eventually when this (Lenz Law) force is equal and opposite to the weight it will continue at constant speed. (2)

(c) There will be no net induced current because the currents produced in the top & bottom wire sections will be in opposite directions and equal in magnitude.(2)

(d) Time for 1 revolution $= \frac{60}{1500} = 0.04\,\text{s}$

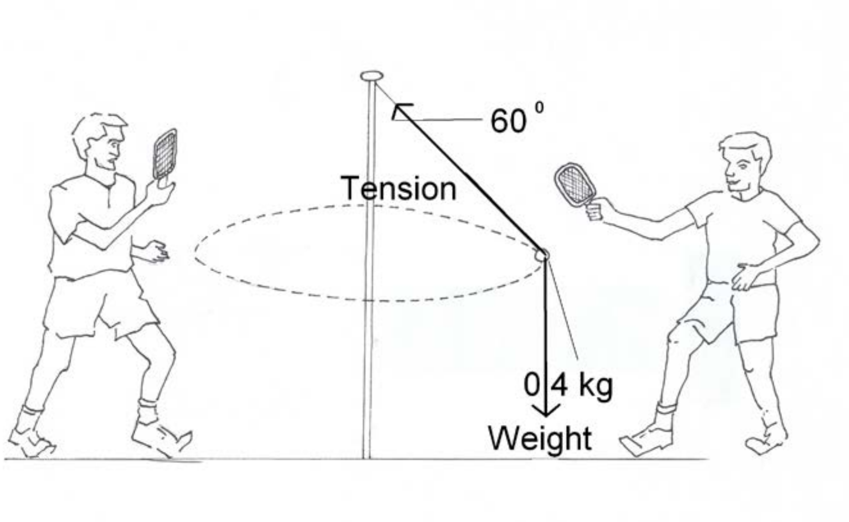
Time to go a quarter revolution = 0.01 s

$$\text{emf} = \frac{100 \times \left(2 \times 10^{-5}(0.2 \times 0.2) - 0\right)}{0.01}$$ (5)

$= 8 \times 10^{-3}$ V

6.

(a)



(2)

(b)

Resolve vertically

$T\cos 60^{o} \;\; m\,g = 0.4 \times 9.8$

$T = 7.84\,\text{N}$ (3)

(c)

Resolve horizontally

$T\cos 30^{o} = \frac{m\,v^{2}}{r}$ $r = 2.5\cos 30^{o} = 2.16\,\text{m}$

$7.84\cos 30^{o} = \frac{0.4\ v^{2}}{2.16}$ (4)

$v = 6.05\,\text{m.s}^{-1}$

(d)

Speed decrease (1), give reason (2) (3)

$$\tan\phi = \frac{\text{Centripetal force}}{\text{Weight}} = \frac{m\,v^{2}}{m\,g\,r}$$

So $v^{2} = g\,r\tan\phi$

So as speed decreases then ϕ will decrease (r depends on tan ϕ proportionally)

7.

(a) Step down voltage transformer,
Change 110 kV to 240 V

$$\text{Turns ratio} = \frac{110 \times 10^3}{240} = 460:1$$ (3)

(b) Line losses reduce
As the voltage is increased then the current is reduced and the line loss I^2R reduced
$P = I^2R$ (3)

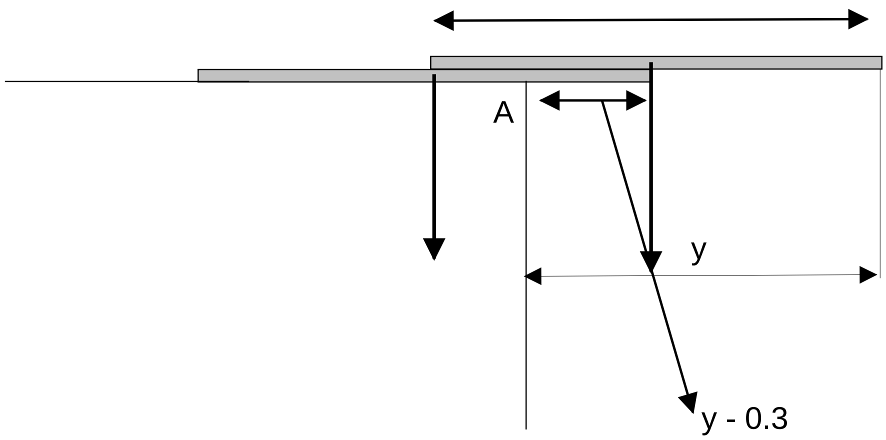
(c) Total resistance $= (200 \times 2 \times 10^{-3}) + 30 = 30.4\,\Omega$
$V = I \times R$
$240 = I \times 30.4$ $I = 7.89$ A
At kettle $V = 7.89 \times 30 = 236.7$ V
Power $= I^2 R = (7.89)^2 \times 30.0 = 1867$W
or $P = VI = 236.7 \times 7.89 = 1867$ W (4)

(d) Current demand will increase so the line loss along the 40 km line will increase

Therefore the output from transformer will be reduced and the power available to

the kettle is decreased. (3)

8. (a)

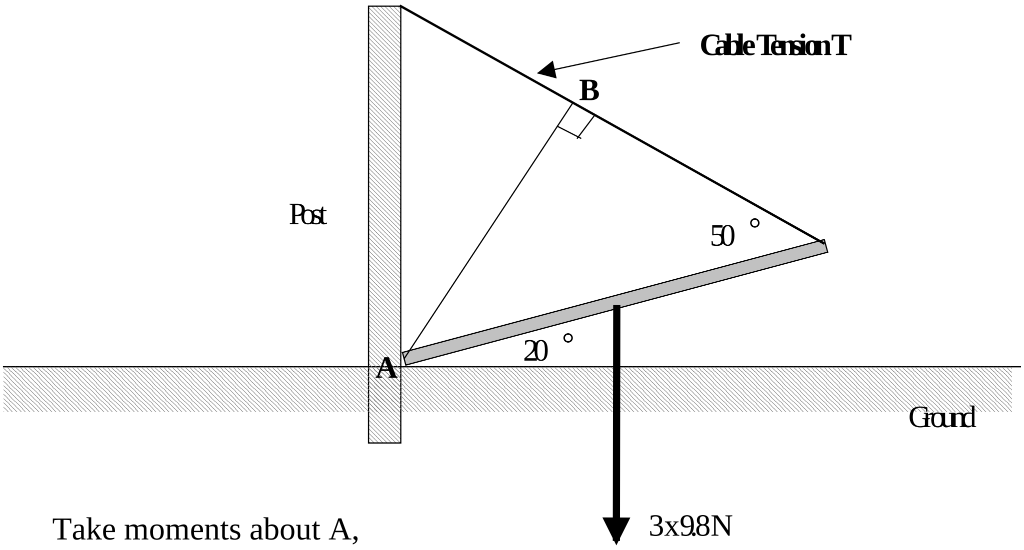


Take moments about the table corner, A.

$$3 \times 9.8 \times (y - 0.3) = 3 \times 9.8 (0.6 - y)$$
$$2y = 0.9$$ (4)
$$y = 0.45\,\text{m}$$

Or by symmetry
$y = 0.45$ m

(b)



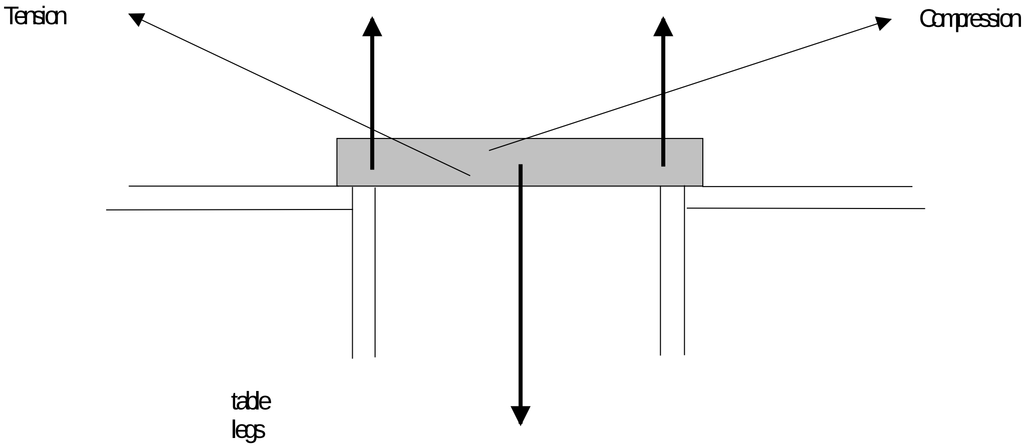
Take moments about A,

$3 \text{ x } 9.8 \text{ x } 0.3 \cos 20^{o} = \text{T x AB}$

$8.28 = \text{T x } 0.6 \sin 50^{o}$ (4)

$\text{T} = 18.0 \text{ N}$

(c)



(4)

END OF SECTION B

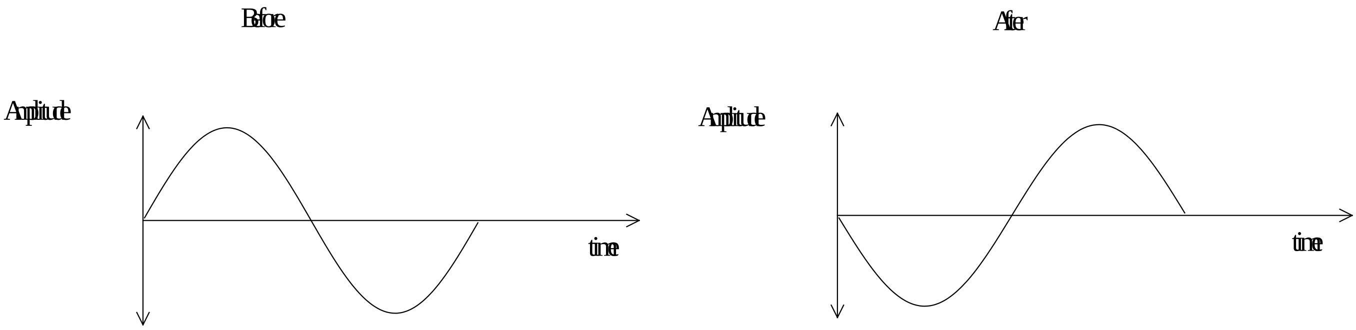
Section C: Comprehension and Interpretation

Question 1.

1. In the future the computers will be more powerful, needing larger microprocessors that will use more power generating more heat and need bigger fans to keep them cool. (2)

2. As the fan moves more quickly it has more kinetic energy and this is passed on to the air particles in the neighbourhood causing them to vibrate with larger amplitude i.e. louder. As the fan rotates more quickly blades impact more frequently on the air molecules increasing the frequency of the sounds. (3)

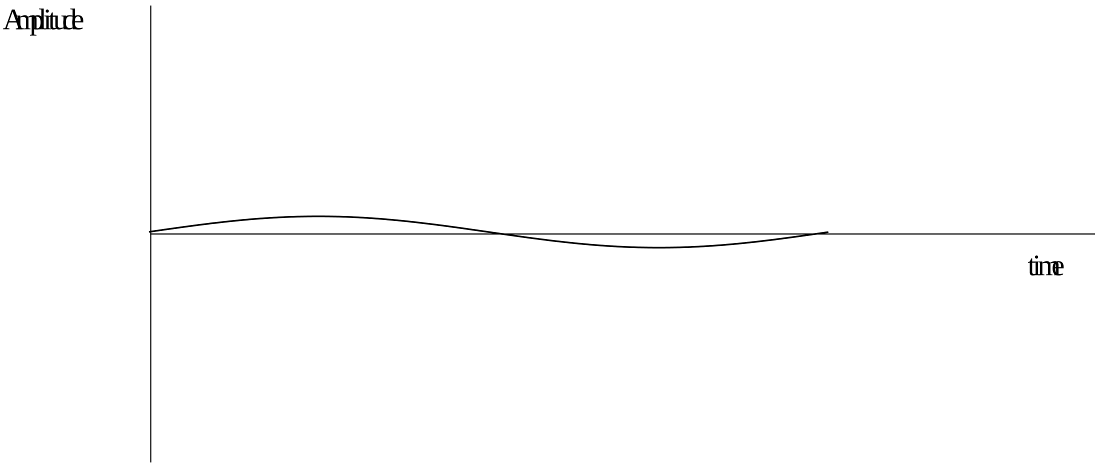
3.



Other shapes are possible but must be out of phase by 180°

(3)

4.



(3)

5. Destructive interference, the law of superposition causes a cancellation of the noise. (2)

6.

$$\text{dB} = 10\log\frac{10^{-8}}{10^{-12}} = 40\,\text{dB}$$

New level is 40 dB – 20 dB = 20 dB

$$20 = 10\log\frac{I_2}{10^{-12}}$$

$$I_2 = 10^{-10}\ \text{W m}^{-2}$$

(3)

7. It has to do with the path difference varying with the distance between the parts of the fan and your head /ears. If this is always changing then by averaging the incoming sound a better noise reduction will be possible.

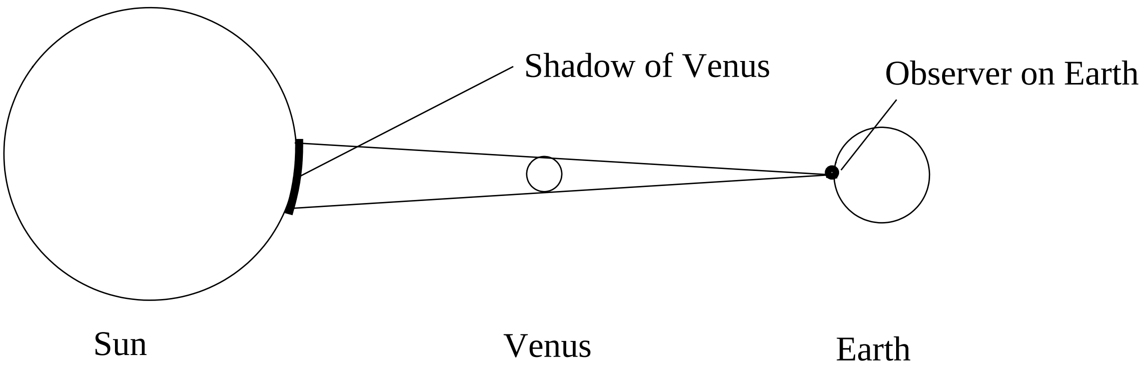
8. Yes after passing through the ANC the sound is quieter. (1)

9. It could be used to reduce unsafe and/or annoying noise. Thus providing a safer and more pleasant environment. Any suitable example (1). The reason stated above (1) e.g. a noisy drill reduced the need for the user to wear ear muffs.

Question 2.

1. Either, those between the earth and the sun or Mercury and Venus only. (2)

2.



(3)

3. The orbital planes are inclined to each other therefore Venus, the Earth and the Sun are rarely lined up. (3)

4.

$$\frac{\text{Sun} - \text{Earth}}{\text{Moon} - \text{Earth}} = \frac{1.5 \times 10^{11}}{3.84 \times 10^{8}} = \frac{1}{0.0025}$$

$$\text{Moon} - \text{Earth} = 0.0025\,\text{AU}$$

(2)

5.

$$T^2 = \frac{4\pi^2 r^3}{G\,m} = \frac{4\pi^2 \left(1.08 \times 10^{11}\right)^3}{6.67 \times 10^{-11} \times 1.99 \times 10^{30}}$$

$$T^2 = \frac{4.97 \times 10^{34}}{1.32 \times 10^{20}}$$ (3)

$$T = 1.93 \times 10^7 \text{ s}$$

6.

$$\tan\theta = \frac{6.4 \times 10^6}{\text{Earth - Sun distance}}$$

$$\text{Earth – Sun distance} = \frac{6.4 \times 10^6}{\tan\left(2.5 \times 10^{-3}\right)} = 1.46 \times 10^{11} \text{ m}$$ (3)

7. So the triangle used to calculate θ is as large as possible so the error is minimised. (2)

8. So as not to confuse the sunspots with the planet Venus. The sun's rays will damage your eye if you view directly. (2)