STAWA
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PHYSICS
2008 TEE SOLUTIONS*

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QUESTION PAPER AND SOLUTIONS
CAN BE OBTAINED FROM:
THE CURRICULUM COUNCIL
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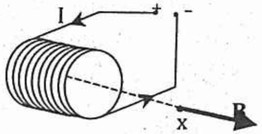
*THESE SOLUTIONS ARE NOT A MARKING KEY. THEY ARE A GUIDE TO THE POSSIBLE ANSWERS AT A DEPTH THAT MIGHT BE EXPECTED OF YEAR 12 STUDENTS. IT IS UNLIKELY THAT ALL POSSIBLE ANSWERS TO THE QUESTIONS ARE COVERED IN THESE SOLUTIONS.

 STAWA ACKNOWLEDGES THE SUPPORT OF THE CURRICULUM COUNCIL AND IN PARTICULAR THE TEE EXAMINING PANEL MEMBERS.

STAWA 2008 Physics solutions

Section A

1. a)



b) The field strength will **increase.**

2. $f = v/\lambda = 340/0.34 = 1000$ vibrations in 1 second
In 50×10^{-3} seconds the No. of cycles will be $1000 \times 50 \times 10^{-3} = 50$ cycles.

3.

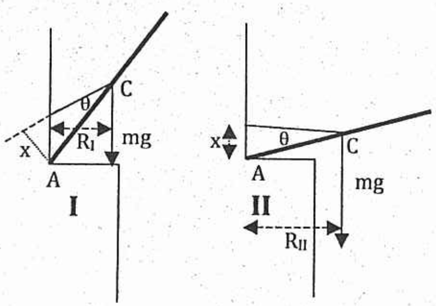
Property	Reflection	Refraction	Diffraction
Frequency	unchanged	unchanged	unchanged
Wavelength	unchanged	changed	unchanged
Speed	unchanged	changed	unchanged

4. Light is an electromagnetic wave which does not require a medium to travel in. Sound is a mechanical wave that needs particles that transfer the energy from one to the other and propagate the wave. Space contains no particles and so sound would not be able to propagate in it.

5. Answer is **B.**
The package and the aeroplane both have the same horizontal velocity when the package is dropped. Although the package accelerates vertically its horizontal velocity remains the same as the aeroplane's (no air resistance) and so when it hits the ground it will have travelled the same distance horizontally along the ground.

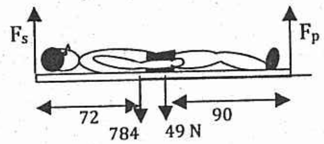
6. For the tyres to lose contact with the road the normal reaction must equal zero.
So: $v^2 > gr = 9.8 \times 120 \quad v = 34.3\ ms^{-1}$

7. The clockwise torque is provided by the flagpole weight (mg) and is greater in diagram II because the distance from the pivot (R_{II}) is greater as
$\tau = mgR$.
The anticlockwise torque needed to overcome this will therefore need to be larger, which is provided by the wire. The lever arm distance to the wire (x) is the same in I and II because the angle is the same, therefore to develop a greater opposing torque the tension force must become larger.
Hence the tension in the wire is greater in case II.



8. Secondary coil: If I = 10 A and R = 6 Ω, then V = IR = 60 volts.
The voltage ratio is therefore 240 : 60 or 4 to 1 which must equal the turns ratio.
N_2 must be ¼ of 20 = 5 turns.

9. Taking torques about right hand end:
$(1.08 \times 784) + (0.9 \times 49) = 1.80 \times F_s$
$F_s = 495$ N



10. a) $E = \dfrac{hc}{\lambda}$ Red: $E_R = \dfrac{6.63 \times 10^{-34} \times 3 \times 10^8}{670 \times 10^{-9}} = 2.97 \times 10^{-19}$ J

Blue: $E_B = \dfrac{6.63 \times 10^{-34} \times 3 \times 10^8}{460 \times 10^{-9}} = 4.32 \times 10^{-19}$ J

Ratio $E_R/E_B = 2.97/4.32 = 0.687$

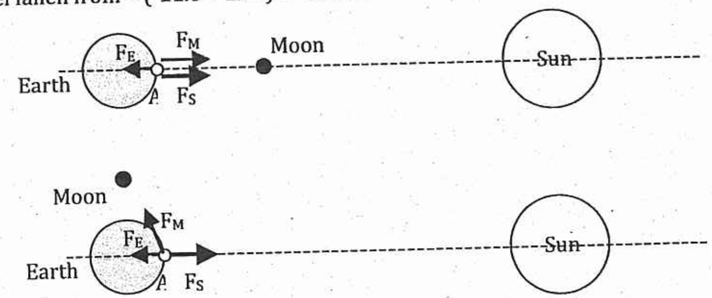
b) No. of red photons emitted: Red $= P/E_R = 100/2.97 \times 10^{-19} = 3.37 \times 10^{20}$
Blue $= P/E_B = 100/4.32 \times 10^{-19} = 2.31 \times 10^{20}$

Ratio $N_R/N_B = 3.35/2.35 = 1.46$

11. $\Delta E = \dfrac{6.63 \times 10^{-34} \times 3 \times 10^8}{652 \times 10^{-9}} = 3.05 \times 10^{-19}$ J

$\Delta E = 3.05 \times 10^{-19}/1.6 \times 10^{-19} = 1.91$ eV
Level fallen from = (-11.6 + 1.91) = -9.70 eV

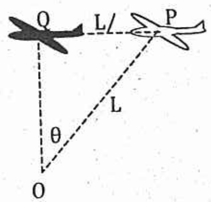
12.



13. Orbital period = 9.07 x 3600 = 32652 s
$R^3 = \dfrac{GMT^2}{4\pi^2} = \dfrac{6.67 \times 10^{-11} \times 9.4 \times 10^{20} \times (32652)^2}{4\pi^2}$
$R = 1.19 \times 10^6$ m so height $= 1.19 \times 10^6 - 480000 = 7..1 \times 10^5$ m.

14. For fundamental freqs: $\lambda_a = 2a \quad \lambda_b = 2b$
also $f_a = v/\lambda_a = v/2a$ and $f_b = v/\lambda_b = v/2b$
$2 f_a = f_b$ so $2v/\lambda_a = v/\lambda_b$ Hence b = 2a (ratio is 1 : 2)
Splitting the string in this ratio gives a = 24 cm and b = 48 cm.

15. By the time the sound travels a distance L and reaches O, the 'plane will have travelled forwards a distance L/2.
$\sin\theta = L/2 \div L = 0.5$
$\theta = 30°$



Section B: Problem-solving

1. a) There would be a repulsive force downwards of 5 N.

   b) Attractive force greater than 5 N as two opposite poles are now close and attracting.

   c) The earth's magnetic north pole attracts the N of the magnet, exerting a torque on the magnet which causes it to rotate and align its axis with the earth's magnetic field lines.

2. a) Beats frequency = 46/20 = 2.3 Hz.

   b) (i) $\lambda = 2L$ so $f = \frac{v}{2L}$ hence $F_B = f_2 - f_1 = \left(\frac{v}{2L_2} - \frac{v}{2L_1}\right)$

   (ii) $2.3 = \frac{v}{2}\left(\frac{1}{L_2} - \frac{1}{L_1}\right) = \frac{v}{2}\left(\frac{1}{0.84} - \frac{1}{0.85}\right)$ $\quad v = 328\ ms^{-1}$

   c) f = v/2L = 328/1.68 = 195 Hz.

   d) F would decrease because the speed of sound in CO_2 is less and f is proportional to v, whilst λ stays the same.

3. a) From equation 1 and 2: $t = \frac{s}{v_o \cos} = \frac{2v_o \sin\theta}{g}$

   Rearranging: $v_o^2 = \frac{gs}{2\cos\theta\sin\theta}$ hence $v_o = \sqrt{\frac{gs}{2\cos\theta\sin\theta}}$

   b) $v_o = \sqrt{\frac{gs}{2\cos\theta\sin\theta}} = \sqrt{\frac{9.8 \times 54.1}{2\cos 40 \sin 40}} = 23.2\ ms^{-1}$

   c) Using $v^2 = u^2 + 2as$: at top $0 = (23.2\sin 40)^2 - 19.6s$ $\quad s = 11.3$ m

4. a) $t = 4333 \times 24 \times 3600 = 3.74 \times 10^8$ s

   b) $v = 2\pi r/t = (2 \times \pi \times 5.2 \times 1.5 \times 10^{11}) / 3.74 \times 10^8 = 1.31 \times 10^4\ ms^{-1}$

   c) $F = \frac{GM_sM_J}{R^2} = \frac{6.67 \times 10^{-11} \times 1.99 \times 10^{30} \times 318 \times 5.98 \times 10^{24}}{(5.46 \times 1.5 \times 10^{11})^2}$

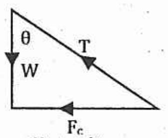
   $F = 3.76 \times 10^{23}$ N

   d) $v^2 = \frac{GM_s}{R} = \frac{6.67 \times 10^{-11} \times 1.99 \times 10^{30}}{(5.46 \times 1.5 \times 10^{11})}$ $\quad v = 1.27 \times 10^4 ms^{-1}$

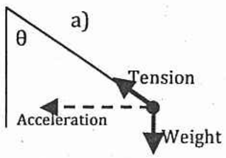
   e) Answer is C

5. a) Forces labelled on ball

   Looking at the vector diagram of the forces, θ can only be zero if the weight is zero and there was no component of the tension to balance W (= mg). This cannot happen.



Vector diagram



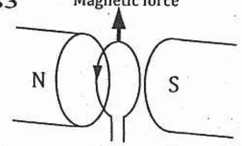
   b) Acceleration vector on diagram.

   c) $T\cos\theta = mg$ so $T = (0.05 \times 9.8)/\cos 75 = 1.89\ N \rightarrow 1.9\ N$

   d) Horizontal radius, $r = 0.5 \sin 75 = 0.483$ m

   $F_c = T\sin 75 = \frac{mv^2}{r}$ so $1.89\sin 75 = \frac{0.05\ v^2}{0.483}$ $\quad v = 4.20\ ms^{-1}$

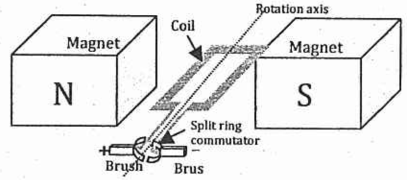
6. a) By the right-hand rule, the magnetic force will be upwards.



   b) D

   c) DC electric motor:

   The coil has many turns and can rotate on an axis between the north and south poles of magnets.
   The current is led into the coil through a split-ring commutator and brushes.
   The magnetic field due to the current interacts with the permanent field to produce a force upward on one side of the coil and downwards on the other, thus producing a torque which will rotate the coil.
   As the coil becomes vertical, the current reverses, due to the split ring, which reverses the force and thus keeps the coil turning in the same direction.



7. a) $F_M = F_C$ so $Bqv = \frac{mv^2}{r}$ $\quad$ Hence $v = \frac{Bqr}{m}$

   b) Upper particle is a Positron.

   c) $F_E = 9 \times 10^9 \frac{(1.6 \times 10^{-19})^2}{(1.7 \times 10^{-3})^2} = 7.97 \times 10^{-23}$ N

   d) To find v: $v = \frac{qBr}{m} = \frac{1.6 \times 10^{-19} \times 0.004 \times 2.8 \times 10^{-3}}{9.11 \times 10^{-31}}$

   $v = 1.967 \times 10^6\ ms^{-1}$

   $F_M = Bqv = 0.004 \times 1.6 \times 10^{-19} \times 1.967 \times 10^6 = 1.26 \times 10^{-15}$ N

   e) The electric force is about 10^8 times smaller and hence can be neglected.

8. a) From the Young's modulus formula:

   $\Delta L = \frac{FL}{AY} = \frac{\frac{1}{2} \times 1800 \times 0.45}{2.5 \times 10^{-4} \times 0.17 \times 10^{11}} = 9.52 \times 10^{-5}$ m

   b) σ = F/A $\quad \sigma = 1.8 \times 10^8$ so $F = 1.8 \times 10^8 \times 2.5 \times 10^{-4} = 4.50 \times 10^4$ N

   c) $\tau = \frac{2\pi^2 r^3 t S\theta}{180l} = \frac{2\pi^2 \times (1.5 \times 10^{-2})^3 \times 0.3 \times 10^{-2} \times 8 \times 10^{10} \times 7}{180 \times 0.45}$

   $\tau = 1.38 \times 10^3$ Nm

   d) $\tau = FL$ so $F = \tau/L = (1.38 \times 10^3)/1.3 = 1.06 \times 10^3$ N.

   e) y = stress, $\sigma = F/A = (0.5 \times 1800)/2.5 \times 10^{-4} = 3.60 \times 10^6$ Pa

   x = strain, $\varepsilon = \sigma/Y = (3.60 \times 10^6)/1.7 \times 10^{10} = 2.12 \times 10^{-4}$

z = strain (ε) = breaking stress/Y = $(1.8 \times 10^8)/1.7 \times 10^{10} = 1.06 \times 10^{-2}$ (1.1×10^{-2})

Section C: Comprehension

1. a) The coil output will be exactly the same as before as flux builds up and reduces in the same way.

b) The coil output will be reversed as the magnetic flux is cut in the opposite direction so the graph will be the same shape but upside down.

c) Number of pulses in 1000 metres = $1000/(2\pi \times 0.27)$ = = 589 pulses

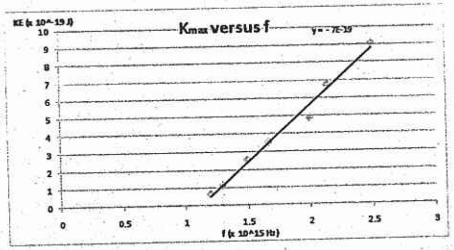
d) $N = \dfrac{4\mathcal{E}R}{\pi\, DR_m B_o v} = \dfrac{4 \times 1.0 \times 0.27}{\pi \times 0.01 \times 0.20 \times 0.10 \times 10} = 172$

e) The direction of the flux lines changes as the coil approaches the centre (from down to up) and increases in strength. Hence $\mathcal{E}$ will reverse and then become larger.

2. a) The wave model could include refraction, diffraction or interference. For instance, with diffraction, light passes through a narrow slit and the energy spreads out into a diffraction pattern of light and dark fringes on the other side.

b)

F ($\times 10^{15}$ Hz)	K_{max} ($\times 10^{-19}$ J)
1.2	0.64
1.3	1.12
1.5	2.56
1.67	3.52
2.0	4.88
2.14	6.72



c) The x-intercept is at f = 1.1×10^{15} Hz.
Work function = hf = $6.63 \times 10^{-34} \times 1.1 \times 10^{15} = 7.29 \times 10^{-19}$ J.

d) Work function in electron-volts = $7.29 \times 10^{-19} / 1.6 \times 10^{-19} = 4.55$ eV.
Closest value in table is for **copper** (4.70 eV)
(Using 1.02×10^{-19} gives 6.4 eV = the value for platinum)

e) $\lambda = v/f = 2.72 \times 10^{-7}$ m = 272 nm which is in the **ultraviolet** region of the spectrum.

f) Yes the ammeter will still register a current. As the stopping potential for all frequencies is negative (repelling electrons) a zero potential will not stop the lower energy electrons from reaching the electrode.