F6 Phy 1st Exam solution
Paper 1

	0	1	2	3	4	5	6	7	8	9
	---	D	A	B	A	D	B	C	C	B
1	C	D	B	A	C	A	A	C	C	B
2	A	C	D	B	A	C	A	B	C	A
3	B	C	D	A	---	---	---	---	---	---

1

(a) **(i)** Energy needed = $ml = (0.01)(2.26 \times 10^6)$ — 1M

$= 22\ 600$ J — 1A

(ii) Energy lost by air = energy gained by water

$mc\Delta T = 22\ 600$

$(8 \times 1.3)(1000)\ \Delta T = 22\ 600$ — 1M

$\Delta T = 2.17$ °C — 1A

(b) The student's claim is not correct. — 1A

If all windows and doors are closed, humidity in the room will gradually build up as the cooler operates. — 1A

This will reduce the rate of evaporation of water, and the cooling ability of the cooler will drop. — 1A

(c) Add ice to the water. — 1A

(Or other reasonable answers)

2.

(a) The pressure inside the container becomes smaller than the atmospheric pressure as some air is pumped out (1A). As a result, the lid is tightly attached to the container.

(b) (i) Applying $pV = nRT$, we have

$$(1.01 \times 10^5) \times 0.002 = n \times 8.31 \times (30 + 273)$$ (1M)

$$n = 0.0802$$

The number of mole is 0.0802 mol. (1A)

(ii) Applying $pV = nRT$, we have

$$p \times 0.002 = (0.0802 - 10 \times 0.001) \times 8.31 \times (30 + 273)$$ (1M)

$$p = 88410$$

The gas pressure is 88410 Pa. (1A)

(c) Applying $F = (\Delta p)A$, we have

$$F = (1.01 \times 10^5 - 88410) \times (0.1 \times 0.1 \times \pi)$$ (1M)

$$= 396\text{ N}$$

The force is 396 N. (1A)

3. (a) i. By $v^2 = u^2 + 2gs$

$= 0 + 2(9.81)(20) \Rightarrow v = 19.8\ ms^{-1}$ — 1A

By $s = ut + ½gt^2$

$20 = 0 + ½(9.81)t^2 \Rightarrow t = 2.02$ s — 1A

ii. $F_{net} = \Delta p/\Delta t$ — 1M

$= (0 - 70 \times 19.8)/0.7$

$= -1980$ N (upward) — 1A

The average force acting on the person by the cushion = 1980 + 70(9.81) = 2667 N — 1A

iii. The KE of the person is changed into the KE of the air "breathed" out from the upper cell of the cushion. — 1A

(b) i. When the air "breathes out" from the upper cell, it collapses so as to minimize the chance of rebounding the person away from the rescue cushion. (OR it collapses so as to increase the time of impact and reduce the force of impact.) 1A

ii. When a person jumps from a height, it is quite possible that he will follow a projectile motion (1A). It is quite difficult to judge the landing position as the horizontal displacement depends on time of flight and also his initial horizontal speed of his jump (1A) (air current/wind/not falling vertically 1A only)

4. (a) Consider the vertical motion from B to C, by $v^2 = u^2 + 2as$,

$v_c^2 = 0 + 2(9.81)(10)$

$\therefore v_c = 14 \text{ ms}^{-1}$ 1A

(b) Consider the motion under water, the KE and PE of the dancer is completely dissipated by the work done against the upward forces (i.e. the buoyancy U and the water resistance f). Let h be the stopping distance under water, we have

$\frac{1}{2}mv_c^2 + mgh = (U + f)h$ 1M

$\frac{1}{2}(80)(14)^2 + (80)(9.81)h = (0.9\times80\times9.81 + 2000)h$

$\therefore h = 4.08$ m

Hence, the depth of the pool should be 4.08 m or more. 1A

Alternate Method

Net upward force acting on the dancer in water = $R_{water} + B - mg = 2000 + 0.9mg - mg = 1921.5$ N

$\therefore$ deceleration = 1921.5/80 = 24 ms^{-2}

By $v^2 = u^2 + 2as \Rightarrow 0 = 14^2 - 2(24)h$ 1M

$\Rightarrow h = 4.08$ m 1A

(c) Consider the energy conservation from A to C, we have

(KE + PE) at A = KE at C

$\therefore \frac{1}{2}mv_A^2 + mgh_A = \frac{1}{2}mv_C^2$ 1M

$\therefore \frac{1}{2}(80)v_A^2 + 80\times9.81\times4 = \frac{1}{2}(80)(14)^2$

$\therefore v_A = 10.8 \text{ ms}^{-1}$ 1A

(d) Consider the vertical motion of the parabolic motion from A to C,

by v = u + at (taking upward is positive), we have

$-14 = 10.8 - 9.81t$ 1M

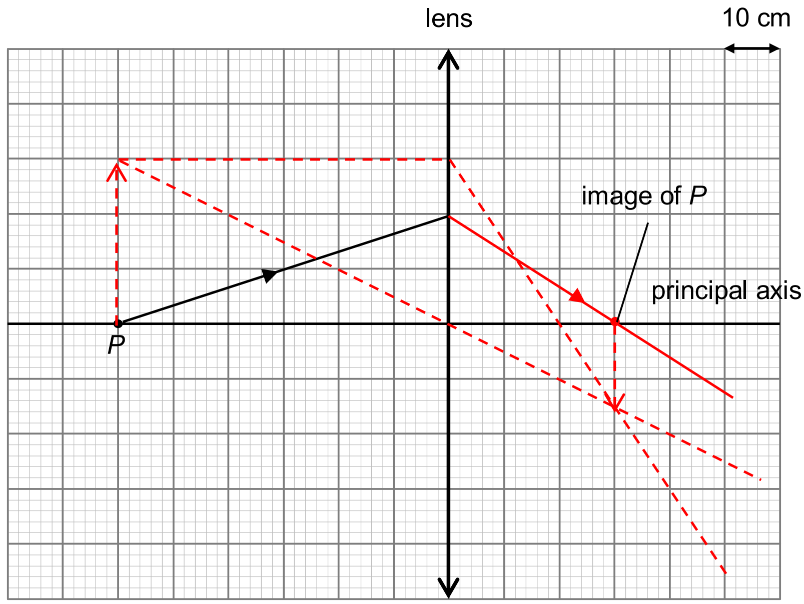
$\therefore$ time of flight, t = 2.53 s 1A

(e) horizontal speed at A = 4.5/2.53 = 1.78 ms^{-1} 1A

(f) Just before the "fly" at A, the dancer has to step hardly onto the platform (1A) of the swing. The work done by his legs enable him to have sufficient KE (1A) to fly up to a position higher than P.

5

(a)



(Correct construction rays to find the image distance) 1A
(Correct location of image) 1A
Lens-to-sensor distance = 30 cm 1A

(b) **(i)** Closer to the camera 1A

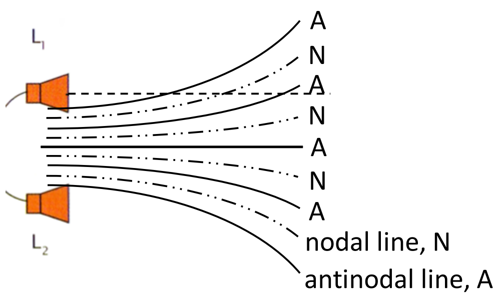
(ii) The picture of *Q* becomes sharper. 1A
Reduce the size of the opening. 1A

(iii) The picture becomes dimmer. 1A

6. (a) period T = 4×0.1 = 0.4 ms
Frequency f = 1/T = 2.5 kHz = 2500 Hz 1A
By v = fλ
∴ λ = v/f = 330/2500 = 0.132 m 1A

(b) The amplitude of the waveform will decrease slowly. 1A

(c)



When both L_1 and L_2 are switched on, the sound waves interfere with each other and produces the interference pattern. 1A
As the mic moves across the nodal line and antinodal line alternately, soft and strong signals will then be received alternately. 1A
Labelled diagram 1A

(d) $CP^2 = AC^2 + AP^2 = 0.6^2 + 0.55^2$ ∴ CP = 0.814 m
Path difference at P = CP – AP = 0.814 – 0.55 = 0.264 m = 2λ 1M
Since path difference at P is whole number multiple of λ, constructive interference occurs at P and gives a large signal. Hence, it agrees with the observation. 1A

(e) 1 more 1A

(f) When L_1 is off, there will not have interference (1A). Hence, the positions with destructive interference will then receive the sound wave from L_2 and the waveform at these positions will restore (i.e. increase) its amplitude (1A).

7. **(a)** When switch *S* is closed, a current passes through the 3-V battery. There will be a potential drop when current passes through the internal resistance of the battery. 1A
Hence, the terminal voltage across the battery drops.

(b) (i) $R_X = R_Y = \frac{V^2}{P} = \frac{3^2}{0.15} = 60\,\Omega$

$\frac{1}{R_{eq}} = \frac{1}{R_X} + \frac{1}{R_Y} = \frac{1}{30}$ 1M

$R_{eq} = 30\,\Omega$

The equivalent resistance of the two bulbs is 30 Ω. 1A

(ii) Power output of the two bulbs

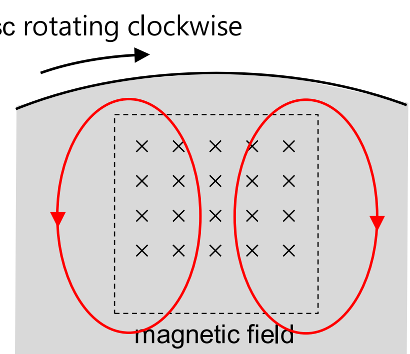
$= \frac{V^2}{R_{eq}} = \frac{2.95^2}{30}$ 1M

= 0.290 W 1A

(iii) When X is blown, the current output from the cell decreases and its output voltage will be larger than before. 1M
Hence, Y will be brighter than before. 1A

8

(a) **(i)**



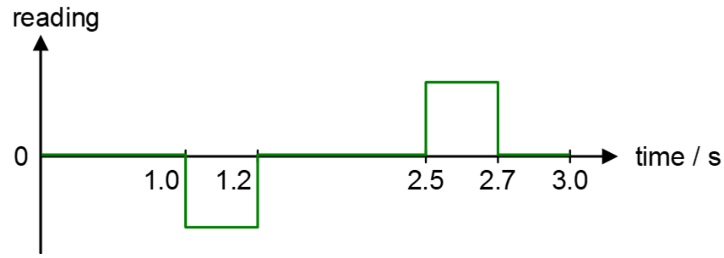
(Correct location of loops) 1A
(Correct direction of arrow) 1A

(ii) In the region of the magnetic field, the induced current flows upwards in the disc. 1A
By Fleming's left-hand rule, the current (and hence the disc) experiences a magnetic force which points towards the left; 1A
thus, slowing down the rotating motion of the metal disc.

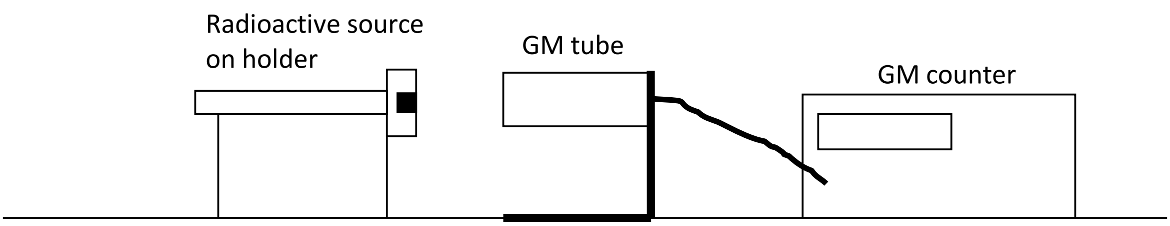
(iii) Any one of the following: 1A
Increase the number of turns of the coil.
Increase the current flowing through the coil.

(b) Advantage:
No material is worn out. 1A
Disadvantage:
The brake is less effective at low speeds. 1A
(Or other reasonable answers)

9

(a) **(i)** 	
(Constant reading for getting into and out of *S*, zero reading in other time periods)	1A
(Correct signs of readings)	1A
(Correct time for getting into and out of *S*)	1A
(ii) Induced e.m.f. $= N\dfrac{\Delta\Phi}{\Delta t}$	1M
$= 50 \times \dfrac{(5\times10^{-4})(0.02\times0.02)}{1.2-1.0}$	
$= 5 \times 10^{-5}$ V	1A
Alternative method:	
Induced e.m.f. $= Bvl$	1M
$= (5 \times 10^{-4})(0.1)(0.02 \times 50)$	
$= 5 \times 10^{-5}$ V	1A
(b) Any two of the following:	2 × 1A
Move the coil faster.	
Using a pair of stronger magnets.	
Using a coil with more turns.	
Increase the length of the coil cutting the magnetic field.	
(c) It will be harder if its two ends are connected to a light bulb.	1A
In this case, a current will flow through the coil when the coil is entering or leaving the magnetic field.	1A
A magnetic force will act on the coil opposing the motion of the coil.	1A
Or Some energy will be dissipated in the light bulb and a larger work is needed to keep the coil moving at a constant speed.	1A

10.



[1A]

With the help of a pair of forceps, fix a radioactive source on the holder. [1A]
Face the radioactive source towards the GM tube with separation less than 2 cm. [1A]
Set up the equipment as in the diagram. Turn on the GM counter & record the radiation count.

Insert a piece of paper between the source and the GM tube and note the change in the radiation count. [1A]
Repeat the observation with the other sources one by one. [1A]
If the insertion of paper can cause the increasing radiation count to stop (or almost stop), the source is a pure α source. [1A]

If the insertion of paper has no significant effect on the increasing radiation count (i.e. keep increasing at a similar rate), the source is a pure γ source. [1A]
If the insertion of paper can significantly slow down the rate of the increasing radiation count, the source is a α and γ source. [1A]

Paper 2

	0	1	2	3	4	5	6	7	8	9
	---	A	C	C	D	A	A	D	C	C
1	B	B	B	B	C	D	D			

1\. (a) i. X = ρc Þ density of air, $\rho = X/c = 411/330 = 1.25$ kgm^{-3} 1A

ii. intensity of reflected ultrasound wave, I' = $\left(\frac{X_1-X_2}{X_1+X_2}\right)^2 I = \left(\frac{1.6\times10^6-411}{1.6\times10^6+411}\right)^2 I = 0.999I$ 1M+1A

∴ transmitted intensity = I – 0.999I = 10^{-3}I or 0.1% transmission 1A

iii. The eardrum has a larger area than that of the oval window. It works together with the lever action of the ear bones, the pressure variation at the ear drum is magnified a few tens time at the oval window which facilitates the transmission of sound signals to the inner ear. 1M+1M

(b) i. 30 phons 1A

ii. $L = 10 \log (I/I_o) \Rightarrow 35 = 10 \log(I/10^{-12})$ 1M

$\Rightarrow I = 3.16\times10^{-9}$ Wm^2 1A

iii. From the graph, the deeper voice is represented by a point which is lower than curve A. Hence, the loudness of the deeper voice is less than to 20 phons which may be too soft for Tom to hear his sayings clearly. 1M

2\. (a) i. The bright is caused by strong reflection of ultrasound pulses by the surface of the gallstone. (1A)

ii. As there is bile (a fluid) inside the gallbladder, it won't reflect ultrasound. Hence, it appears black. (1A)
For region B, it lies behind the gallstone. As the gallstone reflects most of the ultrasound upward, almost no ultrasound can pass downward through region B hence there is no reflected ultrasound from region B and it appears black. (1A)

iii. No. (1A)
Region B can be examined by changing the scanner's position i.e. the region B will not always be "blocked" by the gallstone. (1A)

(b) i. $X_{air} = 1.18\times346 = 408$ kgm^{-2}s^{-1}

$X_{skin} = 1050\times1580 = 1.66\times10^6$ kgm^{-2}s^{-1} 1M

intensity of reflected ultrasound, I' = $\left(\frac{X_1-X_2}{X_1+X_2}\right)^2 I = \left(\frac{1.66\times10^6-408}{1.66\times10^6+408}\right)^2 I = 0.999I$ 1M

$\Rightarrow$ 99.9% reflection 1A

ii. A coupling gel should be applied on the skin so that there is no air between the scanner & the skin. 1A

(c) X-ray is an ionizing radiation which possesses potential danger to the fetus. 1A