Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Mark Schemes

Q1.

(a) hypermetropia ✔

1

(b) Use of $P = \frac{1}{u} + \frac{1}{v}$ correctly. Must see correct substitution for u

or calculation for v, $v = \left(4 - \frac{1}{0.75}\right)^{-1}$ $_1$✔ (= 0.375 m)

Correct substitution in $m = \frac{v}{u}$ $_2$✔ $\left(= \frac{0.375}{0.75}\right)$

0.50 $_3$✔

Correct substitution may be inferred from using the answer as the top line in

Allow PoT for $_1$✔ and $_2$✔

Allow ecf for $_2$✔ (allow ecf for mixing up u and v for this mark, expect to see an answer of 2 for magnification)

No ecf or PoT for $_3$✔

Condone 1SF

MAX 2 if incorrect negative sign seen.

3

(c) **X** – cornea, **Y** – lens, **Z** – iris ✔

X / cornea
form image (on retina) / (primary) refractor / (most of) refraction takes place ✔

First mark is for correctly naming all three parts

Other marks can be gained for attaching the correct description to either the label or the name (if parts not correctly identified)

Treat non optical functions as neutral.

Do NOT allow "to direct the light" for refraction

Y / lens
Accommodation /
varies the focal length / power (of eye) ✔

Condone "change shape to view / focus on objects at different distances" for Y

Z / iris
Control the amount of light entering the eye ✔

Condone intensity if linked to retina or back of the eye.

4

[8]

Q2.

(a) Frequency axis labelled from 100, 1000, 10 000, including the location of 3000 Hz, if marked ✔

Graph line showing a U shape ✔

Lowest point of graph at 3000 Hz ✔

Allow 1000, 10 000 and 100 000 if line ≤ 20 000

3rd mark depends on a valid scale or clear marking of 3000 Hz at the lowest point.

3

(b) (different) frequencies are played (through earphones) and compared to a 1kHz reference signal ✔

Volume is changed until it sounds the same loudness as the reference signal ✔

2

(c) Correct substitution or correct rearrangement ✔

$$I\left(=I_0 10^{\frac{\text{intensity level}}{10}}\right) = 1 \times 10^{-12} \times 10^{\frac{30}{10}} = 1.0 \times 10^{-9} \checkmark \text{ (W m}^{-2}\text{)}$$

e.g. $30 = 10\log \frac{I}{10^{-12}}$

2

[7]

Q3.

(a) Flat panel detector ✔

If flat panel detector, **max 3** from:

Not moving, so fluoroscopic image intensity not required ✔

Saves a picture unlike an intensifying screen ✔

FTP digital image is easier to share or transfer unlike film ✔

Flat panel detector is more sensitive (than film) ✔

Faster than film / film is slower / doesn't have to be developed like film ✔

To minimise dose of X-rays to be used ✔

If film selected

Not moving, so film is preferred to intensifying screen ✔

Saves a picture unlike an intensifying screen ✔

Minimise dose of X-rays to be used (compared to moving image with intensifying screen) ✔

Do NOT accept minimise dose compare to flat panel detector

If image intensifier selected

Intensifying screen is more sensitive (than film) ✔

Condone increases contrast (at low intensity) as an alternative to increase sensitivity

Does not need to be developed like film / real time image ✔

If no selection is made max 2 for correct comments.

Ignore references to resolution / image quality

Treat cost / portability as neutral

4

(b) First mark is for calculating intensity (or power or energy if calculation done in a different order) transmitted through bone (allow thickness < 4 cm if justified as mean eg $r\sqrt{\pi}$ accept r = 0.02 < thickness ≤ d = 0.04) must include a factor $e^{-\mu x}$ ✔

Second mark is for calculating intensity absorbed by bone (or power or energy if calculation done in a different order) ✔

Third mark is for calculating the area of the bone ✔

Fourth mark is for converting an intensity into a power (allow ecf for incorrect intensity, including I_0, or area) ✔

Fifth mark is for converting a power into an energy (allow ecf for incorrect energy) ✔

Expected answer

$I = I_0 e^{-\mu x} = 0.013 \times e^{-58.3 \times 0.04}$ ✔ (= 0.00126)

Absorbed intensity = $I_0 - I = 0.013 - 0.00126$ ✔ (= 0.0117)

Area of bone =

$\sqrt{0.25^2 + 0.09^2} \times 0.04$ ✔ (= 0.0106 m^2)

$P = IA = 0.0117 \times 0.0106$ ✔ (= 0.000124)

$E = Pt = 0.000124 \times 0.8 = 1.0 \times 10^{-4}$ ✔ (J)

(allow 9.9×10^{-5} or 1.1×10^{-4})

Condone rounding of answers/values as estimate asked for.

Award max 4 if PoT error in final answer.

5

(c) Assuming bone has constant thickness / bone is rectangular/cuboid ✔

Allow any other sensible assumption that leads to a larger value

For the first mark it must be clear that the distance referred to is x in the equation $I = I_0 e^{-\mu x}$ and not the mean diameter used to calculate the cross sectional areas.

*First mark can also be gained from an attempt to use an average value for x in **(b)***

Assuming none of the X-rays are absorbed by tissue before it reaches

the bone ✔

Allow some X-rays are scattered (rather than being absorbed) ✔

Treat references to X-rays reflecting as neutral

2

[11]