OCR
Oxford Cambridge and RSA

GCSE Physics A (Gateway)

J249/04 Physics A P5-P8 and P9 (Higher Tier)

Question Set 3

1 Look at the table showing information about the electromagnetic spectrum.

Radio	Micro-wave	Infra-red	Visible light	Ultra-violet	X-rays	Gamma-rays
3 MHz	30 GHz	3 THz		3000 THz	3 000 000 THz	300 000 000 THz
100 m	1 cm	100 µm				

(a) The speed of all electromagnetic radiation is 3×10^8 m/s.

(i) Use data in the table to show that the speed of microwaves is 3×10^8 m/s.

$v = f\lambda$

$f = 30 \times 10^9$ Hz

$\lambda = 1 \times 10^{-2}$ m

$30 \times 10^9 \times 1 \times 10^{-2}$

$= 3 \times 10^8$ m/s

[2]

(ii) Ultra-violet waves typically have a frequency of 3000 THz.

Calculate the wavelength of these ultra-violet waves in nm.

nm $= 10^{-9}$ m

$\frac{v}{f} = \lambda$

$v = 3 \times 10^8$

$f = 3000 \times 10^{12}$

Answer = ...100.... nm

[3]

$\frac{3 \times 10^8}{3000 \times 10^{12}} = 1 \times 10^{-7}$ m

$= 100$ nm

(b) Ultra-violet waves can damage human skin.

Describe the damage caused to human skin by ultra-violet waves.

UV radiation causes skin cells to be ionised. This can cause skin burns and with large exposure, can cause skin cancer.

[1]

(c) Sun cream can be used to protect skin from ultra-violet waves. Sun creams have different sun protection factors (SPF).

Look at the information about a bottle of sun cream.

This sun cream has a SPF of 10. If used sensibly it can allow you up to 10 × longer in the Sun without increasing the risk from ultra-violet waves.

(i) A doctor says 'adults should not sunbathe for more than 20 minutes in the midday sunshine when **not** using sun cream'.

If an adult used sun cream with SPF 6, how long could they safely sunbathe for?

SPF 10 → 10x longer

SPF 6 → 6x longer

Answer = 120 minutes

[1]

6x 20 = 120

(ii) The doctor says that children should always use at least SPF 50 sun cream. Suggest reasons why.

[2]

Children have much more sensitive skin, which is more likely to be burnt. They also move around much more, so can be easily rubbed off or not applied properly.
Amount of UV per surface area is much more too.

[2]

(d)* Ultrasound and X-rays are used to scan patients in hospital.

Look at the information about these two different waves.

Name	Frequency	Wavelength	Type	Description
Ultrasound	≥ 2 MHz	$\leq 1.6 \times 10^{-4}$ m	Longitudinal	Pressure sound wave
X-rays	$\geq 3 \times 10^{16}$ Hz	≤ 10 nm	Transverse	Electromagnetic wave

Ultrasound and X-rays are used to scan different parts of the patient.

Explain how ultrasound and X-rays are used and evaluate the risks and benefits of using these two different waves to scan patients in hospital.

Use the information in the table in your answer.

[6]

Ultrasound

Used to create images of an unborn baby in the womb. To allow the ultrasound waves being transmitted into and out of body, a gel is rubbed onto the skin. Ultrasound waves are reflected by tissue and the signals are used to build images of the baby. Ultrasound waves have no risks and are entirely beneficial.

X-rays

Used routinely in hospitals to investigate problems with bones. This is because X-rays are absorbed by the bones — the images formed highlights where the X-rays have been absorbed in white.

X-rays are a risk as they can cause cancer by mutating cells in the body. However this risk is only a concern if a person has had a large exposure to

X-rays.

In short exposures to X-rays, the benefits outway the risks → which is why they are vital in hospitals today. The benefits are identifying broken bones and examining most areas of the body.

Total Marks for Question Set 3: 15

Equations in physics

(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance

change in thermal energy = mass × specific heat capacity × change in temperature

thermal energy for a change in state = mass × specific latent heat

energy transferred in stretching = 0.5 × spring constant × (extension)^2

potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil

Higher tier only –

force on a conductor (at right angles to a magnetic field) carrying a current = magnetic flux density × current × length