Homework 2: Electromagnetic Spectrum

1. The diagram shows part of the electromagnetic spectrum.

P	Visible light	Q	X-rays

The radiations in regions P and Q are

	Region P	*Region Q*
A	infrared	ultraviolet
B	ultraviolet	microwaves
C	ultraviolet	infrared
D	infrared	microwaves
E	microwaves	ultraviolet

2. A student writes the following statements about electromagnetic waves.

I Electromagnetic waves all travel at the same speed in air.
II Electromagnetic waves all have the same frequency.
III Electromagnetic waves all transfer energy.

Which of these statements is/are correct?

A I only
B II only
C I and III only
D II and III only
E I, II and III

3. A student makes the following statements about different types of electromagnetic waves.

I Light waves are transverse waves.
II Radio waves travel at 340 m s^{-1} through air.
III Ultraviolet waves have a longer wavelength than infrared waves.

Which of these statements is/are correct?

A I only
B I and II only
C I and III only
D II and III only
E I, II and III

4. A student makes the following statements about microwaves and radio waves.

I In air, microwaves travel faster than radio waves.
II In air, microwaves have a longer wavelength than radio waves.
III Microwaves and radio waves are both members of the electromagnetic spectrum.

Which of these statements is/are correct?
A I only
B III only
C I and II only
D I and III only
E II and III only

5. A satellite orbiting the Earth transmits television signals to a receiver.
The signals take a time of 150 ms to reach the receiver.
The distance between the satellite and the receiver is

A $2{\cdot}0 \times 10^{6}$ m
B $2{\cdot}25 \times 10^{7}$ m
C $4{\cdot}5 \times 10^{7}$ m
D $2{\cdot}0 \times 10^{9}$ m
E $4{\cdot}5 \times 10^{10}$ m.

6. A beam of light has a wavelength of $4{\cdot}80 \times 10^{-7}$ m in air.
The frequency of this light is

A $1{\cdot}60 \times 10^{-15}$ Hz
B $2{\cdot}40 \times 10^{-15}$ Hz
C $7{\cdot}08 \times 10^{8}$ Hz
D $4{\cdot}17 \times 10^{14}$ Hz
E $6{\cdot}25 \times 10^{14}$ Hz

7. An electromagnetic wave has a frequency of 330 kHz. In which part of the electromagnetic spectrum does this wave occur?

A visible (400 -700 nm)
B radio waves (1 m - 1 km)
C microwaves (1 mm – 10 cm)
D radar (10 cm – 1 m)
E ultraviolet (700 nm – 1 μm)

8. A student is asked to write down some types of electromagnetic waves in order of increasing wavelength.
The student's answer is **not** correct.

X-rays	Ultraviolet	Infrared	Visible light	Microwaves

Which **two** of these should be exchanged to make the student's answer correct?

A X-rays and infrared
B Visible light and infrared
C Infrared and ultraviolet
D Infrared and microwaves
E X-rays and microwaves.

9. State which of the following is used to detect infrared waves.

A photographic film
B Geiger-Muller tube
C photodiode
D diode probe
E aerial

10. State which of the following is an application of gamma radiation.

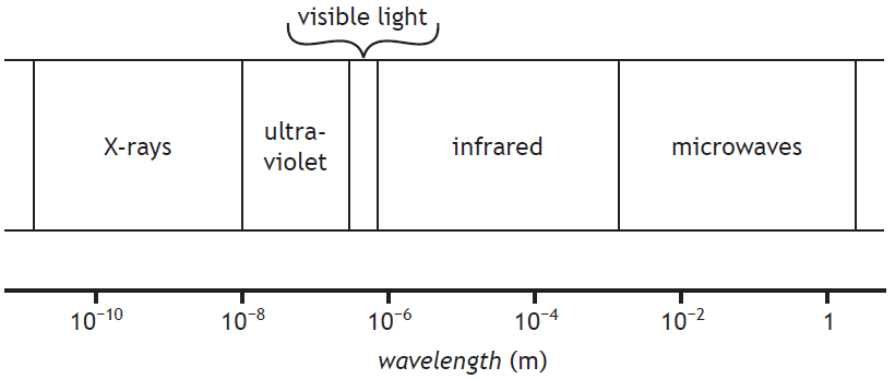
A To detect broken bones
B Sterilising medical instruments
C Detecting forged banknotes
D Thermal camera
E Airport security scanners

11. Typical wavelengths in air of light of different colours are given in the table below.

Colour	Wavelength in air in m
red	$6{\cdot}5 \times 10^{-7}$
green	$5{\cdot}2 \times 10^{-7}$
blue	$4{\cdot}0 \times 10^{-7}$

(a) State the speed of light in air.
(b) The frequency of a certain colour of light is $4{\cdot}6 \times 10^{14}$ Hz.
Identify which colour this light is.
Justify your answer.

12. The diagram shows some parts of the electromagnetic spectrum in order of increasing wavelength.



(a) State a detector of infrared radiation.
(b) State which radiation in the electromagnetic spectrum has a wavelength shorter than X-rays.
(c) (i) An electromagnetic wave has a frequency of 1·2 GHz.
Show that the wavelength of this wave is 0·25 m.
(ii) Identify the part of the spectrum that this wave belongs to.

13. The UV Index is an international standard measurement of the intensity of ultraviolet radiation from the Sun. Its purpose is to help people to effectively protect themselves from UV rays.
The UV index table is shown.

UV Index	*Description*
0 – 2	Low risk from the Sun's UV rays for the average person
3 – 5	Moderate risk of harm from unprotected Sun exposure
6 – 7	High risk of harm from unprotected Sun exposure
8 – 10	Very high risk of harm from unprotected Sun exposure
11+	Extreme risk of harm from unprotected Sun exposure

The UV index can be calculated using

$$UV\ index = \left[\begin{array}{c} total\ effect\ of \\ UV\ radiation \end{array} \times \begin{array}{c} elevation\ above \\ sea\ level\ adjustment \end{array} \times \begin{array}{c} cloud \\ adjustment \end{array} \right] \div 25$$

The UV index is then rounded to the next nearest whole number.

The tables below give information for elevation above sea level and cloud cover.

Elevation above sea level (km)	*Elevation above sea level adjustment*
1	1·06
2	1·12
3	1·18

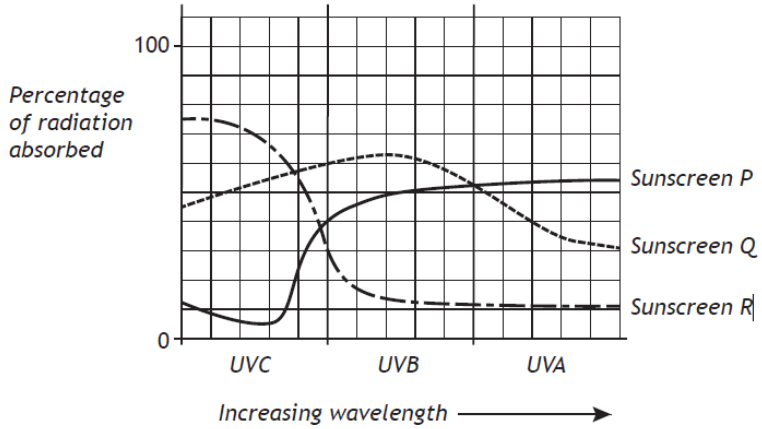
Cloud cover	*Cloud adjustment*
Clear skies	1·00
Scattered clouds	0·89
Broken clouds	0·73
Overcast skies	0·31

(a) At a particular location the total effect of UV radiation is 280.

The elevation is 2 km above sea level with overcast skies.
Calculate the UV index value for this location.

(b) Applying sunscreen to the skin is one method of protecting people from the Sun's harmful UV rays. UV radiation can be divided into three wavelength ranges, called UVA, UVB and UVC.

A manufacturer carries out some tests on experimental sunscreens P, Q and R to determine how effective they are at absorbing UV radiation. The test results are displayed in the graph.



Using information from the graph, copy and complete the following table.

	UVA	*UVB*	*UVC*
Type of sunscreen that absorbs most of this radiation		Sunscreen Q	
Type of sunscreen that absorbs least of this radiation	Sunscreen R		

(c) State one useful application of UV radiation.