

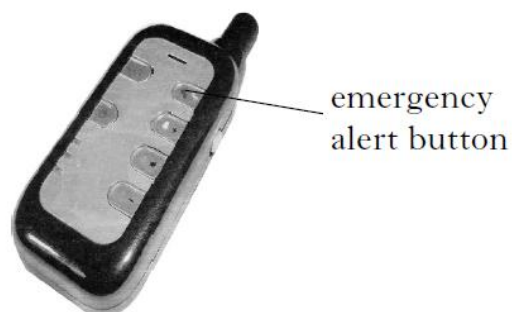


**National 5
Physics**

Waves & Radiation exam questions

**these questions have been collated from
previous Standard Grade (Credit) and
Intermediate 2 exams**

1. A mountain climber carries a device which receives radio signals from satellites to determine the climber's position. The device can also be used to send the climber's position to the emergency services in the event of an accident.



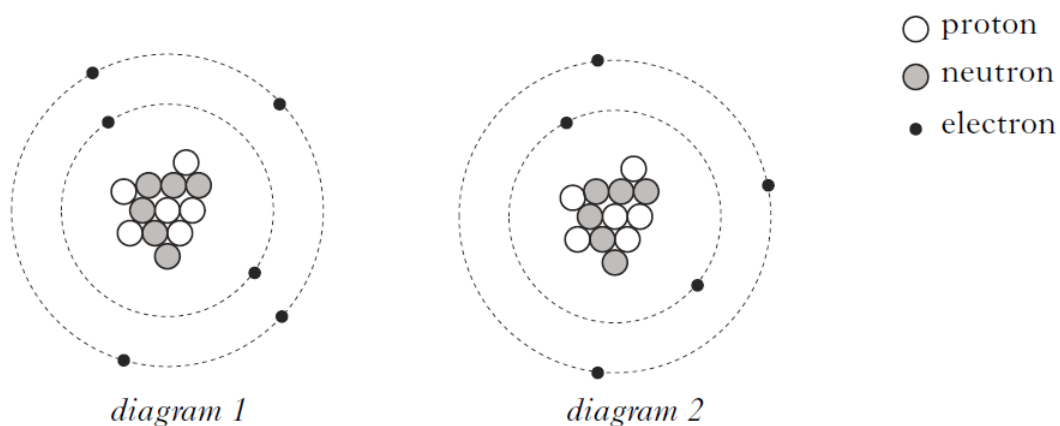
- (a) One satellite sends a radio signal that is received by the device 0.068 s after transmission.
- (i) State the speed of the radio signal. 1
- (ii) Calculate the distance between this satellite and the climber. 3
- (b) The device sends a radio signal to the emergency services. The frequency of the signal is 2100 MHz. Calculate the wavelength of this signal. 3

2. A teacher is demonstrating absorption of alpha, beta and gamma radiations.

(a) The teacher explains that when these radiations are absorbed they may cause ionisation in the absorbing material.

(i) State which of the two diagrams below represents an ionised atom.
Explain your answer.

2



(ii) State which type of radiation: alpha, beta or gamma causes most ionization.

1

(b) The radioactive sources are stored in lead-lined boxes. This is a safety precaution to minimise exposure of students and teacher to radiations from the sources. State **one** further safety precaution that should be taken by the teacher when handling the radioactive sources.

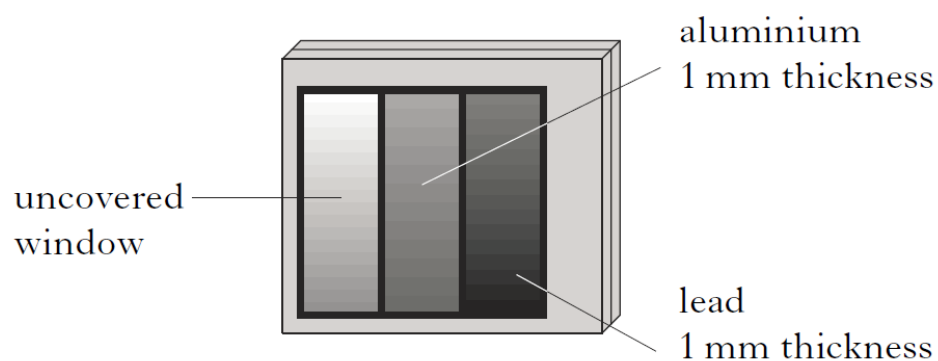
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(c) Radioactive materials are used in hospitals.

(i) State **one** medical use of radiation where the radiation is used to destroy cells.

1

(ii) A hospital physicist is working with some radioactive materials. The physicist wears a badge containing photographic film. Light cannot reach the film.

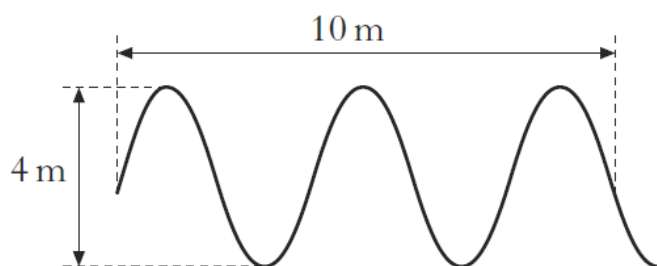


When developed, it is found that the film behind both the uncovered window and the window covered with 1 mm thick aluminium have turned black.

State which type of radiation could cause the film in **only** these areas to turn black.

1

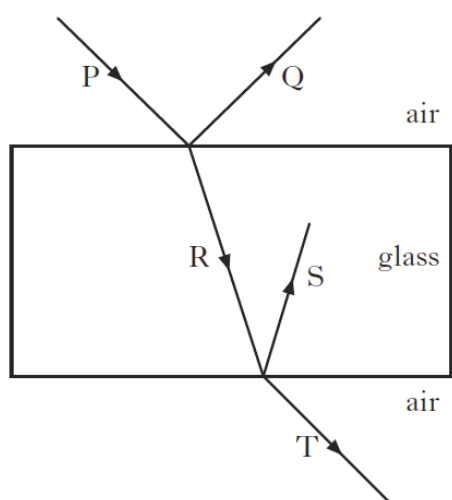
3. The following diagram gives information about a wave.



Which row shows the amplitude and wavelength of the wave?

	Amplitude (m)	Wavelength (m)
A	2	2
B	2	4
C	2	5
D	4	2
E	4	4

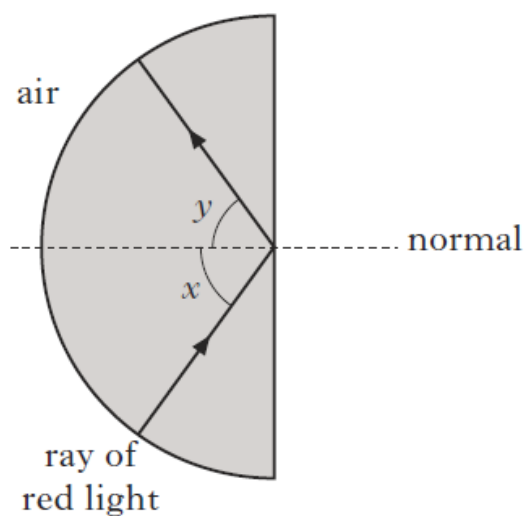
4. The diagram shows a ray of light P incident on a rectangular glass block.



Which of the following are refracted rays?

- A Q and R
- B R and S
- C S and T
- D Q and S
- E R and T

5. The diagram shows the path of a ray of red light in a glass block.



A student makes the following statements.

- I Angle x is equal to angle y .
- II Total internal reflection is taking place.
- III Angle x is the critical angle for this glass.

Which of the following statements is/are correct?

- A I only
 - B II only
 - C I and II only
 - D II and III only
 - E I, II and III
6. Activity and absorbed dose are quantities used in Dosimetry.
Which row shows the unit of activity and the unit of absorbed dose?

	<i>Unit of activity</i>	<i>Unit of absorbed dose</i>
A	gray	becquerel
B	becquerel	sievert
C	becquerel	gray
D	gray	sievert
E	Sievert	gray

7. The table shows the count rate of a radioactive source taken at regular time intervals. The count rate has been corrected for background radiation.

<i>Time</i> (minutes)	10	20	30	40	50
<i>Count rate</i> (counts per minute)	800	630	500	400	315

What is the half-life in minutes of the isotope?

- A 10
B 15
C 20
D 30
E 40
8. In the following passage some words have been replaced by letters X and Y.
In a nuclear reactor, fission is caused by X bombardment of a uranium nucleus. This causes the nucleus to split releasing neutrons and Y.

Which row gives the words for X and Y?

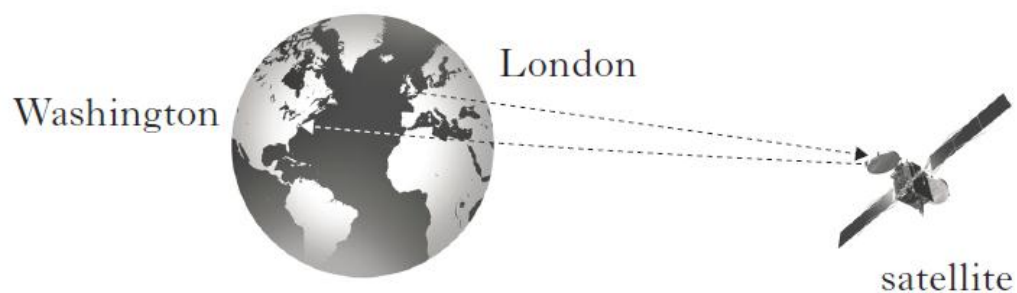
	X	Y
A	neutron	energy
B	proton	energy
C	electron	protons
D	neutron	protons
E	electron	energy

9. In the summer of 2012 the Olympic Games were held in London.

Television pictures of the Games were transmitted from London to Washington via a satellite.

Television signals are transmitted using microwaves.

The diagram shows the signals being transmitted from London to the satellite. This satellite transmitted these signals to a ground station in Washington.



- (a) The frequency of the microwaves used for transmission is 12 GHz.

(i) What is the speed of microwaves?

1

(iii) Calculate the wavelength of these microwaves.

3

10. A band is performing at a music festival.



Drivers in two cars, A and B, are listening to the performance on the radio.

The performance is being broadcast on two different wavebands, from the same transmitter.

The radio in car A is tuned to an AM signal of frequency 1152 kHz.

The radio in car B is tuned to an FM signal of frequency 102.5 MHz.

Both cars drive into a valley surrounded by hills.

The radio in car B loses the signal from the broadcast.

Explain why this signal is lost.

2

11. A toy helicopter is operated using an infrared signal from a remote control. The helicopter has a receiver that can detect infrared radiation.



State a suitable detector of infrared radiation.

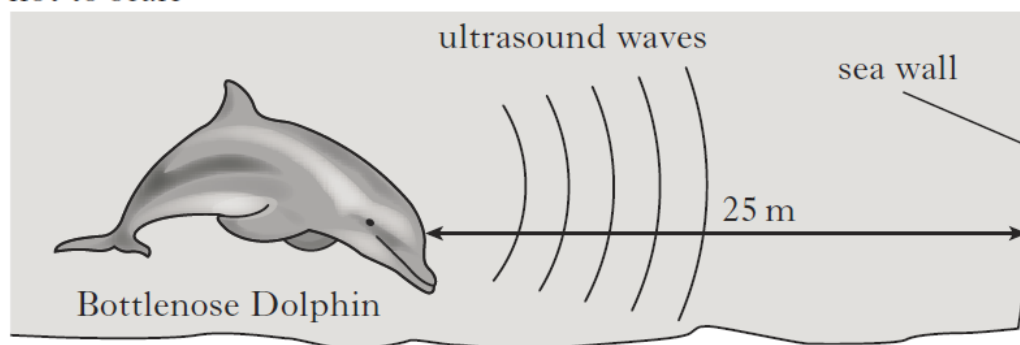
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12. Bottlenose dolphins produce sounds in the frequency range 200 Hz - 150 kHz.

Echolocation is the location of objects by using reflected sound.

Bottlenose dolphins use ultrasounds for echolocation.

not to scale



- (a) A sound of frequency 120 kHz is transmitted through the water by a bottlenose dolphin.
- (i) Use the data sheet to find the speed of sound waves in water. 1
 - (ii) When the dolphin is 25 m from the sea wall, it emits a pulse of ultrasound. Calculate the time taken for this pulse to return to the dolphin. 4
 - (iii) The dolphin changes the frequency of sound it produces to 100 kHz.
 - (A) What effect will this have on the time taken for the pulse to travel the 25 m? 1
 - (B) Explain your answer. 1

13. Aircraft welding joints must be checked regularly for cracks and other faults.
A radioactive source can be used to carry out these checks.

The radiation detector monitors the amount of radiation passing through the section of the aircraft being checked.

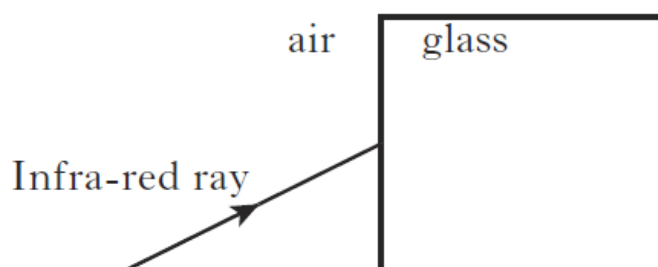
- (a) Explain how a crack in the section of the aircraft would be detected.
- (b) The aircraft has to be checked regularly.
These checks take 24 hours to complete.
The following radioactive sources are available.

<i>Source</i>	<i>Half-Life</i>	<i>Radiation Emitted</i>
W	20 years	Alpha
X	15 hours	Beta
Y	30 years	Gamma
Z	3 hours	Gamma

- (i) State what is meant by the term *half-life*. 1
- (ii) Explain which source would be most suitable for the purpose of detecting cracks in the aircraft. 3
- (c) The lead shield is used as a safety precaution to prevent workers being exposed to a large dose of radiation.
State **one** other safety precaution that is necessary when working with radioactive sources. 1
- (d) A different radioactive source has a half life of 12 hours.
The source has an initial activity of 128 MBq.
Calculate its activity after 2 days. 3

14. Optical fibres are used to carry internet data using infra-red radiation.

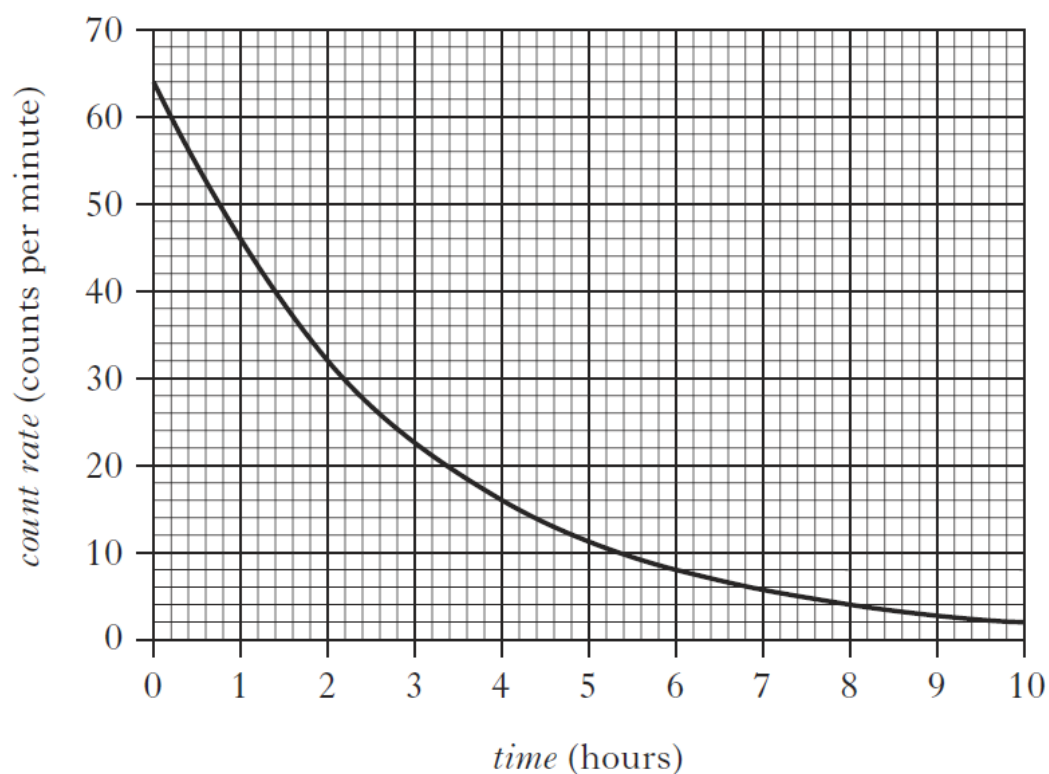
- (a) Is the wavelength of infra-red radiation greater than, the same as, or less than the wavelength of visible light? 1
- (b) The diagram shows a view of an infra-red ray entering the end of a fibre.



Copy and complete the diagram to show the path of the infra-red ray as it enters the glass from air.

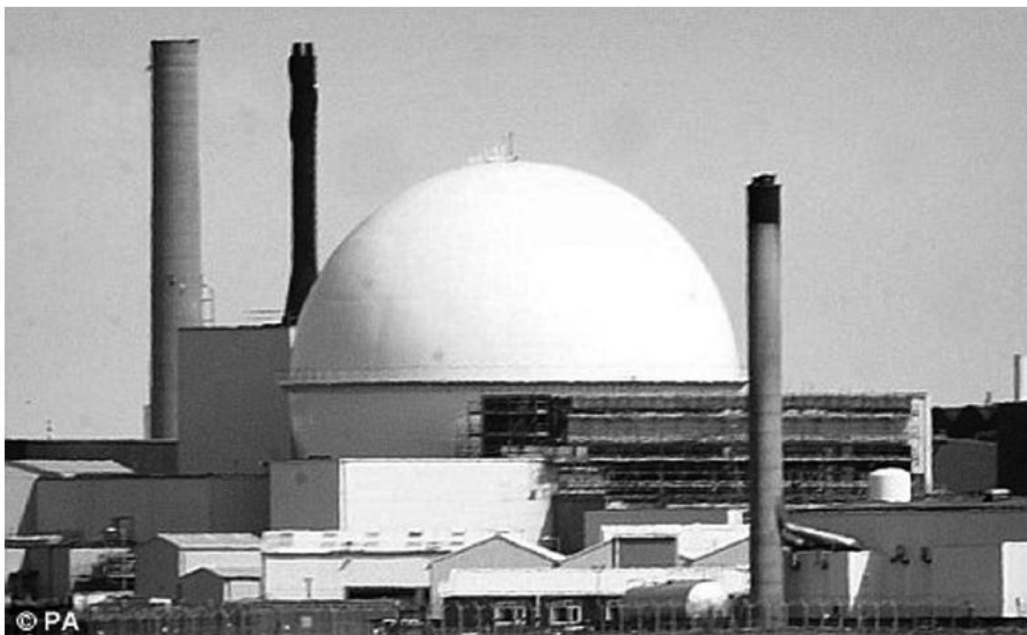
Indicate on your diagram the normal, the angle of incidence and the angle of refraction. 2

15. A technician checks the count rate of a radioactive source. A graph of count rate against time for the source is shown. The count rate has been corrected for background radiation.



- (a) Use the graph to determine the half-life of the source. 2
- (b) State **two** factors which can affect the background radiation level. 2
- (c) The source emits gamma rays. State what is meant by a gamma ray. 1

16. An ageing nuclear power station is being dismantled.



- (a) During the dismantling process a worker comes into contact with an object that emits 24 000 alpha particles in five minutes. The worker's hand has a mass of 0.50 kg and absorbs $6.0 \mu\text{J}$ of energy.

Calculate:

- | | |
|---|---|
| (i) the absorbed dose received by the worker's hand; | 3 |
| (ii) the equivalent dose received by the worker's hand; | 3 |
| (iii) the activity of the object. | 3 |
- (b) What type of nuclear reaction takes place in a nuclear power station's reactor? 1

17. A student makes the following statements.
- I In an atom there are neutrons and electrons in the nucleus and protons which orbit the nucleus.
 - II An alpha particle consists of two neutrons and two electrons.
 - III A beta particle is a fast moving electron.

Which of the statements is/are correct?

- A I only
 - B II only
 - C III only
 - D I and III only
 - E I, II and III
18. A radioactive source emits alpha, beta and gamma radiation. A detector, connected to a counter, is placed 10 mm in front of the source. The counter records 400 counts per minute.
- A sheet of paper is placed between the source and the detector. The counter records 300 counts per minute.
- The radiation now detected is
- A alpha only
 - B beta only
 - C gamma only
 - D alpha and beta only
 - E beta and gamma only.
19. A radioactive tracer is injected into a patient to study the flow of blood. The tracer should have a
- A short half-life and emit α particles
 - B long half-life and emit β particles
 - C long half-life and emit γ rays
 - D long half-life and emit α particles
 - E short half-life and emit γ rays.

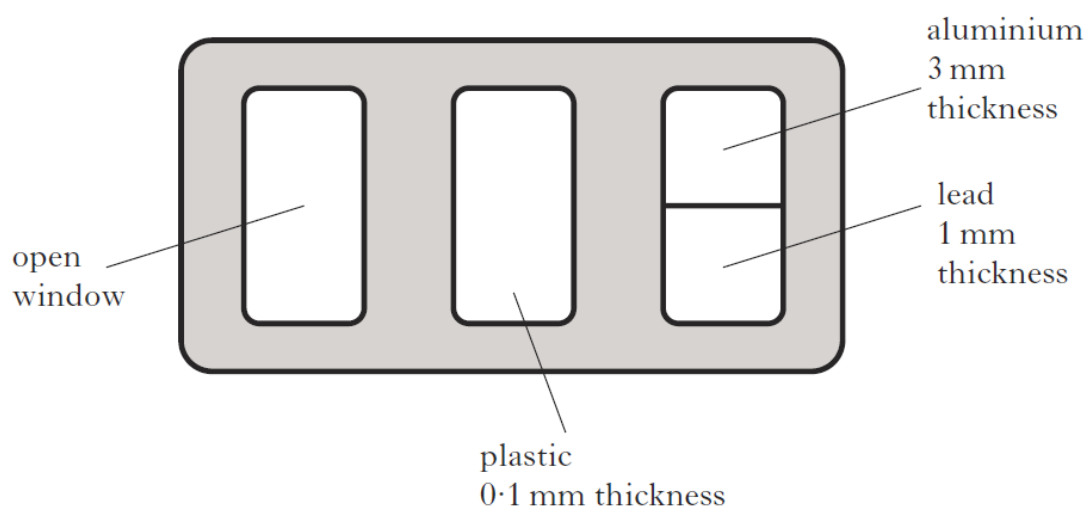
20. The thyroid gland is important for good health as it regulates the rate at which the body produces energy.

Two radioactive sources of iodine are used in medicine. The table shows some of the properties of these sources.

<i>Radioactive Source</i>	<i>Radiation Emitted</i>	<i>Half-Life</i>
Iodine-123	Gamma	13 hours
Iodine-131	Beta	8 days

One of the sources is injected into the body of a patient as a tracer to diagnose problems in the thyroid gland. The other source is injected into the body to treat cancer of the thyroid gland.

- (a) Explain why Iodine-123 should be used as a tracer to diagnose problems in the thyroid gland. 1
- (b) The patient is injected with a sample of Iodine-123. The sample has an activity of 12 MBq when injected.
The patient had a check-up at 8 am on May 3rd and the activity is now 1.5 MBq.
Calculate the time and date when the Iodine-123 was injected. 3
- (c) Some hospital staff wear film badges to monitor their exposure to radiation. The film is contained in a plastic holder with windows of different materials as shown in the diagram. Light cannot reach the film.



- (i) Shade the window or windows where the film would be affected if the wearer is exposed to the Iodine-123 isotope. 1
- (ii) Describe how the badge would be used to indicate how much radiation the member of staff has been exposed to. 2

21. Images from outer space can be obtained using space telescopes.



Radioastron



Hubble



James Webb

Two space telescopes which orbit the Earth are the Hubble space telescope and the Radioastron space telescope.

The Hubble space telescope completes one orbit of the Earth in 97 minutes.

The Radioastron space telescope completes one orbit of the Earth in 9.5 days.

- (a) How does the orbital height of the Hubble space telescope compare with the orbital height of the Radioastron space telescope? 1
- (b) The telescopes detect radiations which are members of the electromagnetic spectrum.

A diagram showing the electromagnetic spectrum is shown. 1

Gamma rays	P	Q	Visible light	Infra red	Microwave	Radio and TV
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Electromagnetic Spectrum

Name radiations P and Q.

- (c) The Hubble space telescope is nearing the end of its useful life and will be replaced with the James Webb space telescope.

The James Webb space telescope is designed to detect infra-red radiation from outer space.

Name a detector of infra-red radiation. 1

22. A hospital radiographer calculates the equivalent dose of radiation absorbed by a patient. This is done by multiplying the absorbed dose by a radiation weighting factor.

- (a) During a scan of the patient's brain, the absorbed dose is measured as 1.5 mGy. The mass of the brain is 1.4 kg.

Calculate the energy absorbed by the brain during the scan.

3

- (b) In another medical procedure, a radioactive chemical is injected into a patient.

The chemical is prepared by the technician from a source which has an activity of 320 MBq.

The source has a half-life of 6 hours.

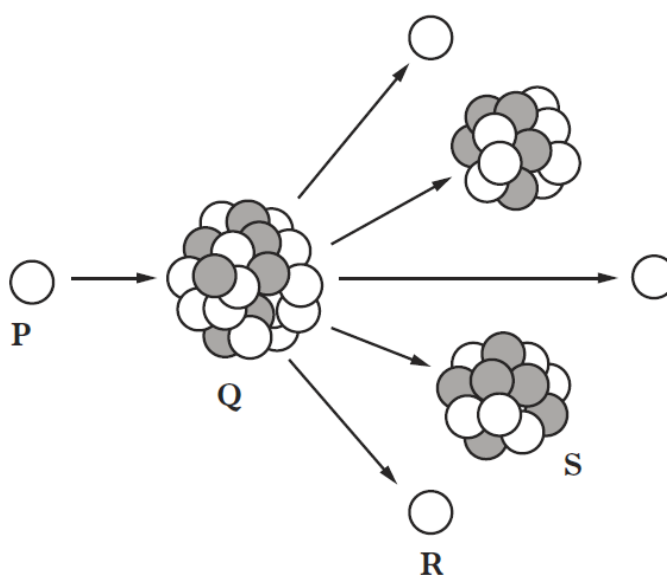
Calculate the activity of the source 18 hours later.

3

23. (a) A student is researching information on nuclear reactors.

The following diagram is found on a website.

It illustrates a type of reaction that takes place in a reactor.



- (i) What type of nuclear reaction is shown in the diagram?

1

- (ii) The labels have been omitted at positions P, Q, R and S on the diagram. State clearly what each of these labels should be.

2

24. Which of the following electromagnetic waves has a higher frequency than microwaves and a lower frequency than visible light?

- A Gamma rays
- B Infrared
- C Radio
- D Ultraviolet
- E X-rays

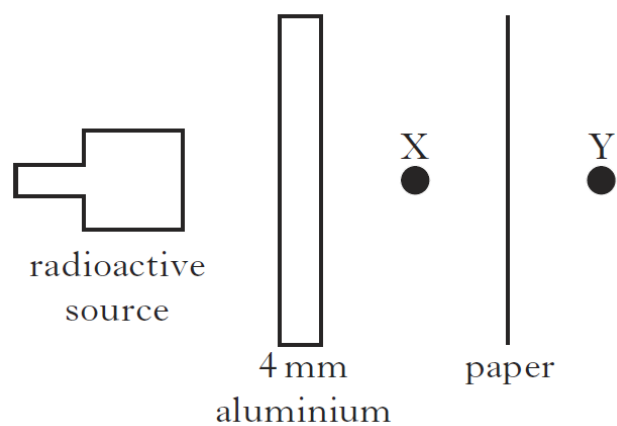
25. A student makes the following statements.

- I The nucleus of an atom contains protons and electrons.
- II Gamma radiation produces the greatest ionisation density.
- III Beta particles are fast moving electrons.

Which of the statements is/are correct?

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

26. A radioactive source emits α , β and γ radiation.
Sheets of aluminium and paper are placed close to the source as shown.



Which row in the table shows the radiation(s) from the source detected at points X and Y?

	<i>Radiation(s) detected at X</i>	<i>Radiation detected at Y</i>
A	α, γ	γ
B	β, γ	α
C	α	β
D	β	γ
E	γ	γ

27. Which of the following describes the term ionisation?

- A An atom losing an orbiting electron.
- B An atom losing a proton.
- C A nucleus emitting an alpha particle.
- D A nucleus emitting a neutron.
- E A nucleus emitting a gamma ray.

28. A student makes the following statements about radiation.

- I The half life of a radioactive source is half of the time it takes for its activity to reduce to zero.
- II The activity of a radioactive source is the number of decays per minute.
- III The risk of biological harm from radiation depends on the type of tissue exposed.

Which of the statements is/are correct?

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