

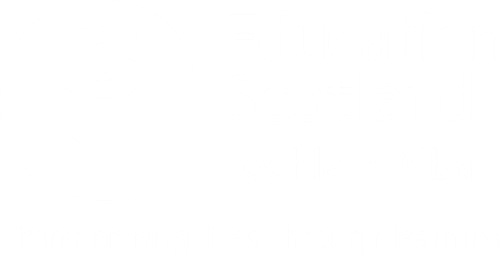
**National 5 Physics**

**Relevant Past Paper Questions from SQA Standard Grade Credit**

**and Intermediate 2 papers**

**Unit 2: Waves and Radiation**

**March 2014**



Transforming lives through learning

**N5 Physics Past Paper Questions**

This resource has been produced in response to the requests from practitioners who attended the National Qualifications Sciences events at Hampden Stadium in December 2013 which Education Scotland organised in partnership with the SQA.

The questions in this resource relate to the Waves and Radiation Unit for National 5 Chemistry and have been taken from the 2011, 2012 and 2013 Standard Grade and Intermediate 2 Past Papers.

For Waves and Radiation (Unit 2), the mandatory course key areas are as follows:

* Wave parameters and behaviours
* Electromagnetic spectrum
* Light
* Nuclear Radiation

In cases where the questions relate to more than one of the National 5 Units, the constituent parts of the question have been separated into their respective key areas. The stem of the question has been retained to give the context of the question. If practitioners require the full integrated question, they should refer to the original past paper on the [SQA website](http://www.sqa.org.uk/pastpapers/findpastpaper.htm?subject=Chemistry&level=).

Past paper questions for the other two National 5 Units, Energy and Electricity and Dynamics and Space, are also available from Education Scotland’s National Qualifications Glow portal: <http://www.educationscotland.gov.uk/nqcoursematerials/>(cut and paste link into your browser).

Education Scotland would like to acknowledge the support of the SQA in helping us produce this resource. We hope it proves helpful to practitioners across Scotland and assists with the implementation of the national qualifications.

Wave parameters and behaviours

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| St Gr 2011 Q 1  (a)ii & (b) | 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. | Marks |
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| (a) | One satellite sends a radio signal that is received by the device 0.068 s after transmission. |
| (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 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **1** | (a) | (ii) | d = v t (1)  = 3 x 108 x 0.68 (1)  = 20 400 000 m (1) | 3 | Must use value for speed from (a)  OR correct value for speed of radio signals  If *v* = 340, then *d* = 23·12 m |
|  |  |  | (1)  (1)  (1) | 3 | Must use value for speed from (a)  OR correct value for speed of radio signals  Sig. fig range: 0·1, 0·14, 0·143, 0·1429  If *v* = 340, then λ = 1·62 × 10-7m |

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| St Gr 2012 Q 1 (b)ii | 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. | Marks |
|  | The frequency of the microwaves used for transmission was 12 GHz. |  |
|  | Calculate the wavelength of these microwaves. | 3 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
|  | (b) |  | (1)  (1)  (1) | 3 | deduct for wrong/missing unit (1) |

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| St Gr 2012 Q 2 (b) | A band is performing at music festival. | Marks |
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|  | The festival is being broadcast live on radio. |  |
|  | 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 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **2** |  |  | FM waveband has short(er) wavelength (1)  These radio waves do not diffract around hills (1) | 2 | First mark for describing FM as short(er) wavelength/higher frequency  Second mark for indicating that short wavelength/higher frequency waves do not diffract as much.  Answer can be given in the context of A and B.  Do not accept: Waves “bend”  These are **independent** marks. Candidates can still achieve (1) mark for correct description of long wavelengths/low frequencies diffracting.  Answer can be given in the context of A and B. |

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| St Gr 2012 Q5 (b)i +ii | 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. | Marks |
|  |  |  |
| (b) | 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 |
| (c) | The dolphin changes the frequency of sound it produces to 100 kHz. |  |
| (i) | State the effect this will have on the time taken for the pulse to travel the 25 m. | 1 |
| (ii) | Explain your answer. | 1 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
|  | (b) |  | (1)  (1) | 4 | Must use value for speed from (b)(i)  OR correct value for speed of sound waves in water  Multiplication by 2 can happen at any stage (eg t = 0.017s x 2 = 0.034 s – while this is imprecise calculation it can be ignored – no penalty)  Deduct (1) for wrong/missing unit in final answer  \*check significant figures  Check calculations to see if candidate has doubled distance at start or double time at end. This could have an impact on significant figure issues.  Watch intermediate rounding issues (eg pupil may round to 0.02s x 2 = 0.04s) – this is acceptable |
|  | (c) | (i) | Time interval is unchanged | 1 | Any indication that changing the frequency has no effect on the time |
|  |  | (ii) | Speed (of sound in water) is same/unchanged.  Frequency has no effect (on the time taken for the wave to travel the 50m) | 1 |  |
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| St Gr. 2013 Q 2 (b) iv | In the aircraft industry non-destructive metal testing is used to look for flaws in aluminium propellers.  Ultrasound pulses are sent at from a transmitter into the propeller being tested. If there are no flaws in the propeller the ultrasound will be reflected from the back edge of the propeller as shown at position A. The reflected signal is detected by a receiver. If a flaw is present inside the propeller a reflection from the flaw will take place inside the propeller as shown at position B. | Marks |
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|  | The frequency of the ultrasound pulses is 15 MHz.  Calculate the wavelength of the ultrasound pulses in the propeller. | 3 |

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| **Question** | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **2** |  |  | V = f λ (1)  5200= 15 x 106 x λ (1)  λ= 3·5 × 10–4 m (1) |

**Electromagnetic Spectrum**

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| St Gr. 2012 Q1(b)i | 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. | Text | Marks |
|  | The frequency of the microwaves used for transmission was 12 GHz. |  |  |
| (a) | State the speed of microwaves. | 1 |  |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **1** | (a) |  | 3 x 108 m s-1  OR  300 000 000 m s-1 | 1 | (1) OR (0) must show correct unit  Do not accept:  “The speed of light” |

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| St Gr 2012 Q 4a | A toy helicopter is operated using an infrared signal from a remote control. The helicopter has a receiver that can detect infrared radiation. | Marks |
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| State a suitable detector of infrared radiation. | 1 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **4** |  |  | Phototransistor/photodiode/CCD | 1 | NOT thermometer/thermopile/ thermogram - not suitable for given context  Not  Infrared camera  OR  Infrared detector |

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| St Gr. 2012  Q14 (b) +(c) | Images from outer space can be obtained using space telescopes. | Marks |
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|  | Two space telescopes which orbit the Earth are the Hubble space telescope and the Radioastron space telescope. |  |
| (b) | The telescopes detect radiations which are members of the electromagnetic spectrum.  A diagram showing the electromagnetic spectrum is shown. |  |
|  |  |  |
|  | Electromagnetic Spectrum |  |
|  | Name radiations P and Q.  **P**  **Q** | 1 |
| (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 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **14** | (a) |  | P = X-rays  Q = Ultra violet/UV | 1 |  |
|  | (b) |  | (Black bulb) thermometer  OR  photodiode  OR  phototransistor | 1 | Accept:   * thermofilm * thermistor * thermopile * thermocouple * thermographic film * heat sensitive paper * IR film * CCD   Do not accept:   * skin * IR camera * photographic film * thermogram |
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| Int 2 2012 Q27 | Optical fibres are used to carry internet data using infra-red radiation. | Marks |
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| (a) | State if the wavelength of infra-red radiation is greater than, the same as, or less than the wavelength of visible light. | 1 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **27** | (a) |  | Greater | 1 | Accept bigger, larger, longer but not higher |

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| Int 2 2013 Q 13 | Which of the following electromagnetic waves has a higher frequency than microwaves and a lower frequency than visible light? | Marks |
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| **Question** | | | **Answer** |
| 13 |  | B | |

**Light**

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| Int 2 2011 Q 15 | The diagram shows a ray of light P incident on a rectangular glass block. | Marks |
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|  | Which of the following are refracted rays? |  |
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| **Question** | | | **Answer** |
| 15 |  | E | |

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| Int 2 2011 Q 16 | The diagram shows the path of a ray of red light in a glass block | Marks |
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|  | 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? |  |

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| **Question** | | | **Answer** |
| 16 |  | C | |

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| Int 2 2012 Q17 | The diagram shows two rays of red light X and Y passing through a block of glass. | Marks |
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|  | |  | | --- | | The critical angle of the glass for this light is | |  | |  |

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| **Question** | | | **Answer** |
| 17 |  | C | |

**Nuclear Radiation**

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| St Gr. 2011 Q 6 | A teacher is demonstrating absorption of alpha, beta and gamma radiations. | Marks |
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| (a)(i) | (A) State which of the two diagrams below represents an ionised atom. | 1 |
|  | (B) Explain your answer. | 1 |
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| (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. | 1 |
| (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. |  |
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|  | 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 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **6** | (a) | (i)  (A) | Diagram 2 (represents ionized atom) | 1 |  |
|  |  | (i)  (B) | An electron has been removed (from the atom) | 1 | For this mark must explain that:  Electron has been removed OR  Fewer electrons **than protons** |
|  |  | (ii) | Alpha (accept symbol α) | 1 | Accept:   * Wash hands * Do not eat * Wear protective clothing * Use shielding * Return to container as soon as demo is * finished   Or other *suitable* alternative |
|  | (b) |  | Use forceps/don’t point at eyes/wear gloves etc | 1 |  |
|  | (c) | (i) | Instrument sterilisation/treatment of cancer | 1 |  |
|  |  | (ii) | Beta (radiation) (accept symbol β) | 1 |  |
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| St Gr. 2012 Q6 | Aircraft welding joints must be checked regularly for cracks and other faults.  A radioactive source can be used to carry out these checks. | Marks |
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The radiation detector monitors the amount of radiation passing through the section of the aircraft being checked.

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| (a) | Explain how a crack in the section of the aircraft would be detected. | 1 |
| (b) | The aircraft has to be checked regularly.  These checks take 24 hours to complete.  The following radioactive sources are available. |  |
|  |  |  |
| (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 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **6** | (a) |  | The radiation detector would detect a higher level of radiation  OR  count rate would be higher where there was a crack in the aircraft | 1 | Some indication that there would be an **increase** in the reading on the detector.  A change in radiation level must be clearly indicated in the context of the chosen detector. e.g. darkening of photographic film (but not an indication that the photographic film changes colour). |
|  | (b) | (i) | Time taken for the (radio) **activity** (of a radioactive source) to reduce by half. | 1 | Do not accept:  Time for radiation/count rate to half. |
|  |  | (ii) | Source Y (1)  gamma can penetrate through the metal aircraft (1)  Long half life (1). | 3 | Y only acceptable answer.  Additional (1) marks can only be obtained if Y is selected.  (Note: for this question, although a beta source could be used the half life of the source in the table is too short to be useful.) |
|  | (c) |  | Point away from face / people  OR  use tongs/ forceps  OR  Use lead (lined) aprons/gloves etc. | 1 | Accept:   * Wash hands * Do not eat * Wear protective clothing * Goggles * Film badge to **monitor exposure** * Limit exposure time * Increased distance from source. * Return to container as soon as demo is finished   Or any other *sensible* alternative  NOT:   * “Film badge” on its own-must have some explanatory statement about its monitoring function * “wear gloves” * “gloves” alone |
|  | (d) |  | 48/12 = 4 ( half lives) (1)  128 🡪 64 🡪 32 🡪 16 🡪 8 (MBq)  (1) for halving (1) for final answer | 3 | Unit not required but deduct (1) if wrong unit given in final answer  Halving process (1) mark is independent of the calculation of the number of half lives.  So candidates who show less or more halvings can still get this (1) mark, but all halving stages must be arithmetically correctly halved. |

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| St Gr. 2013  Q6 | 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. | Marks |
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|  | 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. |  |
| (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. |  |
| (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. |  |
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| (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. | 1 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **6** | (a) |  | gamma radiation can penetrate the body  OR  as beta radiation cannot penetrate the body | 1 | Accept:   * Penetrate * Pass through * Body does not absorb gamma (or converse for a beta answer)   Do not accept:   * Answers relating to half-life only. * escapes from * ‘It’ can penetrate the body. |
|  | (b) |  | 12 🡪 6 🡪 3 🡪 1.5 (MBq) (1)  3 half-lives (can be implied)  3 × 13 = 39 (hours) (1)  5pm on May 1st (or 17:00 on 1st May) (1) | 3 | Any halving (or doubling process 1.5 🡪 3 🡪 6 🡪12) (1) mark is independent of the number of half-lives. |
|  | (c) | **(i)** | All windows shaded | 1 | (1) or (0) |
|  |  | **(ii)** | The blacker the film the more radiation they have been exposed to. | 1 | Accept:   * Darker * Foggier   Relating to the film  Do not accept:   * the film changes colour alone. * the film clouds * answers relating to film **badge** / window. |

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| Int 2 2011 Q17 | Activity and absorbed dose are quantities used in Dosimetry.  Which row shows the unit of activity and the unit of absorbed dose? | Marks |
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| **Question** | | | **Answer** |
| 17 |  | C | |

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| Int 2 2011 Q18 | The table shows the count rate of a radioactive source taken at regular time intervals. The count rate has been corrected for background radiation. | Marks |
|  | What is the half-life in minutes of the isotope? |  |
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| **Question** | | | **Answer** |
| 18 |  | D | |

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| Int 2 2011 Q19 | 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? | Marks |
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| **Question** | | | **Answer** |
| 19 |  | A | |

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| Int 2 2012 Q18 | 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? | Marks |
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| **Question** | | | **Answer** |
| 18 |  | C | |

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| Int 2 2012 Q 19 | 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 | Marks |
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| **Question** | | | **Answer** |
| 19 |  | E | |

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| Int 2 2012 Q20 | A radioactive tracer is injected into a patient to study the flow of blood.  The tracer should have a | Marks |
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| **Question** | | | **Answer** |
| 20 |  | E | |

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| Int 2 2012 Q29 | 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. | Marks |
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| (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 |
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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **29** | (a) | |  | | --- | | Any two correct count rate values from the graph,  i.e. second = half of the first. (1)    Half-life = 2 hours (1) | |  | | | 2 |  |
|  | (b) |  | Any two valid answers. 2 x (1) | 2 | Weapons, atmosphere, rocks etc must be qualified in terms of radioactivity. |
|  | (c) |  | A type of electromagnetic radiation / wave/ ray. | 1 | Don’t accept EM |

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| Int 2 2012 Q30 | An ageing nuclear power station is being dismantled. | Marks |
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| During the dismantling process a worker comes into contact with an object that emits 24 000 alpha particles in five minutes.  Calculate the activity of the object. | 3 |

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| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| **30** |  |  | A = N (1)  t    = 24,000 (1)  (5 x 60)  = 80 Bq (1) | 3 | If time not/wrongly converted max (2) |

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| Int 2 2013 Q 17 | 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? | Marks |
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| **Question** | | | **Answer** |
| 17 |  | C | |

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| Int 2 2013 Q 18 | A radioactive source emits αβand γradiation.  Sheets of aluminium and paper are placed close to the source as shown. | Marks |
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|  | Which row in the table shows the radiation(s) from the source detected at points X and Y? |  |
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| **Question** | | | **Answer** |
| 18 |  | E | |

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| Int 2 2013 Q 19 | Which of the following describes the term ionisation? | Marks |
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| **Question** | | | **Answer** |
| 19 |  | A | |

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| --- | --- | --- |
| Int 2 2013 Q 20 | 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. | Marks |
|  |  |  |
|  | Which of the statements is/are correct? |  |
|  |  |  |

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| **Question** | | | **Answer** |
| 20 |  | C | |

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| --- | --- | --- |
| Int 2 2013 Q 30 (c) | In a 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 | Marks  3 |
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| --- | --- | --- | --- | --- | --- |
| **Question** | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** |
| 30 |  |  | Time (hr) 0 6 12 18  Activity MBq 320 160 80 40 halving (1)  halving activity 3 times (1)  Answer = 40 MBq (1) | 3 | Accept other methods if correct  Answer not made clear (– 1) |

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| --- | --- | --- |
| Int 2 2013 Q 31 (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. | Marks |
|  |  |  |
|  |  |  |
| (a) | Name the type of nuclear reaction is shown in the diagram. | 1 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Question** | | | | **Expected Answer/s** | **Max Mark** | **Additional Guidance** | | |
| 31 | (a) | |  | Fission | 1 | Accept induced fission  Chain reaction 0 marks  Must be spelt correctly | | |
|  | |  | | | | |  |