T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Science

Occupational specialism assessment (OSA)

Laboratory Sciences

Assignment 2 - Part A

Assignment brief

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Contents

Experimental practical

Scenario

In 2011 an ocean floor earthquake, measuring 9.0 on the Richter scale, triggered a tsunami that struck the eastern shore of Japan. Much of the infrastructure for power was interrupted because of the earthquake.

Fukushima Daiichi nuclear power station is situated in the Fukushima Prefecture (district) north of Tokyo on the east coast of Japan. The earthquake and tsunami caused the power supply to the cooling systems to fail. This led to the nuclear piles overheating. A meltdown followed and radioactive material was released.

This was rated a level 7 incident, as high as that of the 1984 Chernobyl disaster.

The Japanese government created exclusion zones around the Fukushima Daiichi nuclear power station and evacuated citizens.

Following the incident, the Japanese government declared a ban on the shipment and sale of various foods from the area; to this day, many Japanese consumers prefer not to purchase produce from this area.

Produce is regularly tested to determine radioactive isotope content. Samples are sent to private testing facilities to ensure scientific rigour and reproducibility. These samples are tested independently, and current data is either confirmed or challenged.

Your laboratory has received numerous samples of rice from the Fukushima Daiichi area. It is the responsibility of the laboratory:

- to test the samples
- to determine if the samples can be considered radioactive
- to identify the isotopes present
- to contest or confirm whether the data supports use of these products within the human food chain

As part of your role within the laboratory, you will need to complete the following tasks:

- use laboratory equipment to determine the levels of radioactivity in given samples as an indication of whether further testing is required
- analyse data from test results using appropriate statistical techniques

Task 1

Task 1(a)

Use the given standard operating procedure (SOP) to carry out a practical investigation to determine whether various rice samples sourced from Fukushima Daiichi can be considered radioactive. To do this you will:

- set up the Geiger counter and record background radiation
- use calibration masses to ensure a balance is calibrated
- measure out a known mass of sample
- carry out a procedure to determine the radioactive count rate for different samples of rice from Fukushima Daiichi
- record results in a suitable table

During the practical you will be observed by an assessor who will make judgements on your ability to carry out the experiment with due care.

(23 marks) (3 hours total for task 1(a) and task 1(b))

Task 1(b)

Transfer results to a LIMS system and determine the radioactive count rate of the samples. Apply relevant statistical techniques to the data collected to determine whether the samples that have been tested can be considered radioactive or not.

(12 marks) (3 hours total for task 1(a) and task 1(b))

Standard operating procedure (SOP)

Process title: determining radioactive count rate of food samples

Introduction

Risk assessment

Substance, equipment or procedure	Hazard	Risk	Controls
Samples of rice	Potential emission of radiation	Ionising effect of radiation	Samples of rice being used have been tested to ensure levels of radioactivity are not considered a risk to health. Exposure to samples should still be kept to a minimum. Use aluminium trays and coverings when transporting samples to minimise risk from beta emission. Use correct personal protective equipment (PPE).

Apparatus

- balance
- calibration masses for balance
- aluminium trays with lids
- Geiger counter
- retort stand and clamp
- ruler
- samples of rice (3 different samples from 2020, 2021 and 2022)

Standard operating procedure (SOP)

The apparatus list is not exhaustive, and changes may be required depending on the type of Geiger counter available to you.

Control test to determine the background radiation with the aluminium tray

1) Fix the Geiger counter in the retort stand and clamp
2) Position the Geiger counter a suitable height above an empty aluminium tray
3) Switch the Geiger counter on
4) Record the counts for 60 seconds – counts per minute (cpm) – in a suitable table
5) Repeat these steps 5 to 10 times using different locations in the laboratory
6) Record results in a suitable table

Collecting data on samples sourced from the Fukushima Prefecture

1) Use the calibration masses provided to ensure the balance is fit for purpose, escalating as appropriate if not
2) Measure out an appropriate mass of the 2020 sample of rice into an aluminium tray and cover when not testing
3) Fix the Geiger counter in the retort stand and clamp
4) Position the Geiger counter a suitable height above the rice sample considering any isotopes potentially present emits beta radiation
5) Switch the Geiger counter on
6) Record the counts for 60 seconds – cpm – in a suitable table
7) Repeat this 5 to 10 times
8) Repeat the above steps for the 2021 and 2022 sample of rice

Determining the radioactive count rate of samples

Transfer your recorded results to a LIMS system. For each set of repeat measurements:

- calculate the mean background radiative count rate in cpm
- calculate the mean radiative count rate for the samples of rice in cpm
- calculate the standard deviation for each set of repeats

Determine the radioactive count rate in cpm of the various samples by subtracting the average background rate. If this results in a quantity below 0, the radioactive count can be determined as 0.

Comment on whether any further investigation is needed into the radioactivity of samples tested.

Evidence to be submitted

At the end of the task, ensure the following records are submitted to the invigilator:

- written results labelled with (Provider_number)_(Student registration number)_(Surname)_(First name)_Assignment 2 Part A
- LIMS system data, saved using the following file name format: (Provider_number)_(Student registration number)_(Surname)_(First name)_Assignment 2 Part A

References

Standard operating procedure (SOP) amended from: www.spark.iop.org/collections/teaching-radioactivity

Document information

Owner: Head of Assessment Design