Gleniffer High School

“A – Team”

Past Papers

Nuclear Radiations Homework

Mr Downie 2022

DATA SHEET

Speed of light in materials

Material	*Speed* in $m\,s^{-1}$
Air	$3{\cdot}0 \times 10^8$
Carbon dioxide	$3{\cdot}0 \times 10^8$
Diamond	$1{\cdot}2 \times 10^8$
Glass	$2{\cdot}0 \times 10^8$
Glycerol	$2{\cdot}1 \times 10^8$
Water	$2{\cdot}3 \times 10^8$

Gravitational field strengths

	Gravitational field strength on the surface in $N\,kg^{-1}$
Earth	9·8
Jupiter	23
Mars	3·7
Mercury	3·7
Moon	1·6
Neptune	11
Saturn	9·0
Sun	270
Uranus	8·7
Venus	8·9

Specific latent heat of fusion of materials

Material	*Specific latent heat of fusion* in $J\,kg^{-1}$
Alcohol	$0{\cdot}99 \times 10^5$
Aluminium	$3{\cdot}95 \times 10^5$
Carbon Dioxide	$1{\cdot}80 \times 10^5$
Copper	$2{\cdot}05 \times 10^5$
Iron	$2{\cdot}67 \times 10^5$
Lead	$0{\cdot}25 \times 10^5$
Water	$3{\cdot}34 \times 10^5$

Specific latent heat of vaporisation of materials

Material	*Specific latent heat of vaporisation* in $J\,kg^{-1}$
Alcohol	$11{\cdot}2 \times 10^5$
Carbon Dioxide	$3{\cdot}77 \times 10^5$
Glycerol	$8{\cdot}30 \times 10^5$
Turpentine	$2{\cdot}90 \times 10^5$
Water	$22{\cdot}6 \times 10^5$

Speed of sound in materials

Material	*Speed* in $m\,s^{-1}$
Aluminium	5200
Air	340
Bone	4100
Carbon dioxide	270
Glycerol	1900
Muscle	1600
Steel	5200
Tissue	1500
Water	1500

Specific heat capacity of materials

Material	*Specific heat capacity* in $J\,kg^{-1}\,°C^{-1}$
Alcohol	2350
Aluminium	902
Copper	386
Glass	500
Ice	2100
Iron	480
Lead	128
Oil	2130
Water	4180

Melting and boiling points of materials

Material	*Melting point* in °C	*Boiling point* in °C
Alcohol	−98	65
Aluminium	660	2470
Copper	1077	2567
Glycerol	18	290
Lead	328	1737
Iron	1537	2737

Radiation weighting factors

Type of radiation	*Radiation weighting factor*
alpha	20
beta	1
fast neutrons	10
gamma	1
slow neutrons	3

Nuclear Radiations One

1. A student makes the following statements about a carbon atom.

I The atom is made up only of protons and neutrons.

II The nucleus of the atom contains protons, neutrons, and electrons.

III The nucleus of the atom contains only protons and neutrons.

Which of the statements is/are correct?

A I only

B II only

C III only

D I and II only

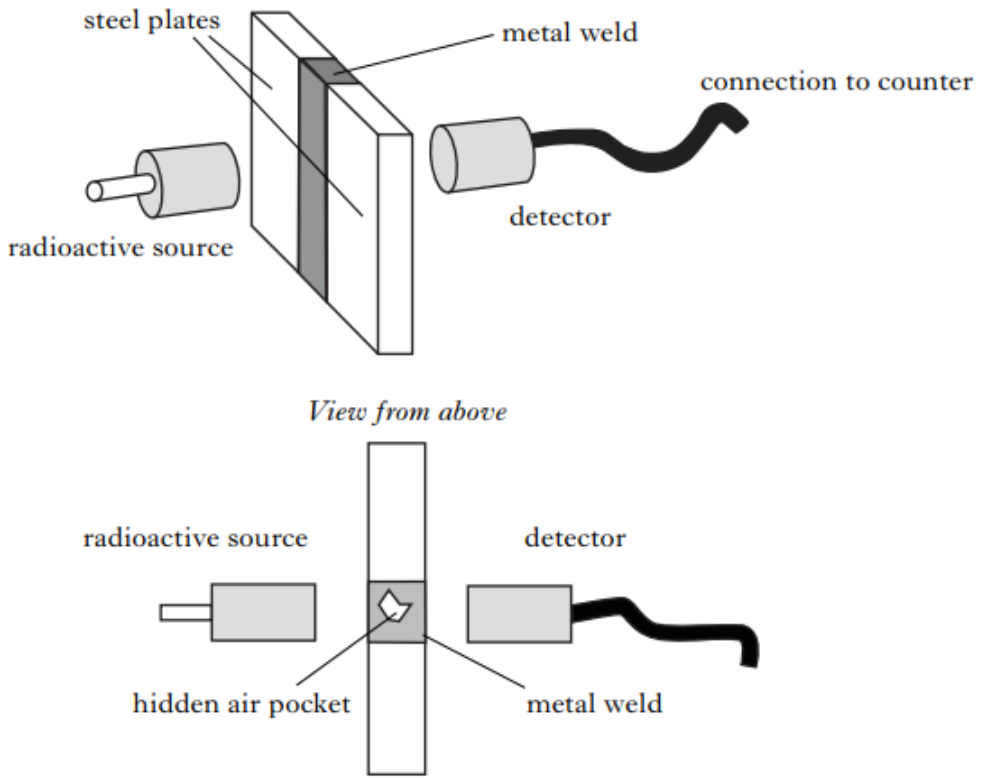
E I and III only

2. Which row in the table describes an alpha particle, a beta particle, and a gamma ray?

	Alpha particle	Beta particle	Gamma ray
A	neutron	helium nucleus	electromagnetic radiation
B	helium nucleus	electron	electromagnetic radiation
C	hydrogen nucleus	electromagnetic radiation	electron
D	helium nucleus	electromagnetic radiation	neutron
E	hydrogen nucleus	electron	electromagnetic radiation

3. When welders join thick steel plates it is important that the joint is completely filled with the metal. This ensures there are no air pockets in the metal weld, as this would weaken the joint.

One method of checking for air pockets is to use a radioactive source on one side of the joint. A detector placed as shown measures the count rate on the other side.



a) The radioactive source and detector are moved along the weld. How would the count rate change when the detector moves over an air pocket?

Explain your answer.

2

b) Which of the radiations, alpha, beta or gamma must be used?

Explain your answer.

2

c) X-rays are sometimes used to detect air pockets. How does the wavelength of X-rays compare with the wavelength of gamma rays?

1

4. An airport worker passes suitcases through an X-ray machine.

a) The worker has a mass of 80 kg and on a particular day absorbs 7.2 mJ of energy from the X-ray machine.

i) Calculate the absorbed dose received by the worker.

3

ii) The radaiation weighting factor for X-rays is 1. Calculate the equivalent dose received by the worker.

3

b) X-rays can cause ionisation. Explain what is meant by ionisation.

1

c) The worker wears a badge containing photographic film. Explain how this can indicate if the worker has been exposed to radiation.

1

Nuclear Radiations Two

1. For a particular radioactive source, 1800 atoms decay in a time of 3 minutes. The activity of this source is

A 10 Bq

B 600 Bq

C 1800 Bq

D 5400 Bq

E 324 000 Bq

2. One Gray is equal to

A one becquerel per kilogram

B one sievert per second

C one joule per second

D one sievert per kilogram

E one joule per kilogram

3. Information about a radioactive source is given in Table 1

Table 1

Activity	*Energy absorbed per kilogram of tissue*	*Radiation weighting factor*
500 MBq	0·2 μJ	10

Which row in Table 2 gives the correct information for the radioactive source?

Table 2

	Absorbed Dose	Equivalent Dose
A	0.2 μGy	2 μSv
B	500 MGy	10 Sv
C	10 Gy	0.2 μSv
D	20 μGy	50 MSv
E	2 μGy	0.2 μSv

4. In a nuclear reactor a chain reaction releases energy from nuclei.

Which of the following statements describes the beginning of a chain reaction?

A An electron splits a nucleus releasing more electrons.

B An electron splits a nucleus releasing protons.

C A proton splits a nucleus releasing more protons.

D A neutron splits a nucleus releasing electrons.

E A neutron splits a nucleus releasing more neutrons.

5. In 1908 Ernest Rutherford conducted a series of experiments involving alpha particles.

a) State what is meant by an alpha particle.

1

b) Alpha particles produce a greater ionisation density than beta particles or gamma rays. What is meant by the term ionisation?

1

c) A radioactive source emits alpha particles with a half-life of 4 hours. The source has an initial activity of 9.6 kBq.

Calculate the time for the activity to decrease to 600 Bq

3

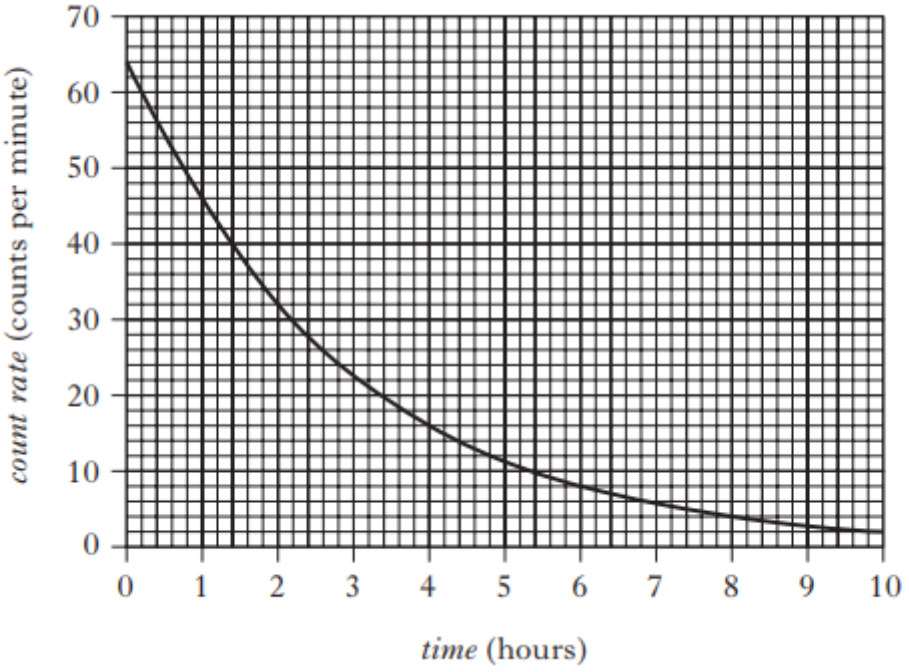
d) Calculate the number of decays in the source in two minutes, when the activity of the source is 1.2 kBq.

3

e) Some sources emit alpha particles and are stored in lead cases even though alpha particles cannot penetrate paper. Suggest a possible reason for storing these sources using this method.

1

6. 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 affect the background radiation level.

2

c) The source emits gamma rays. State what is meant by a gamma ray.

1