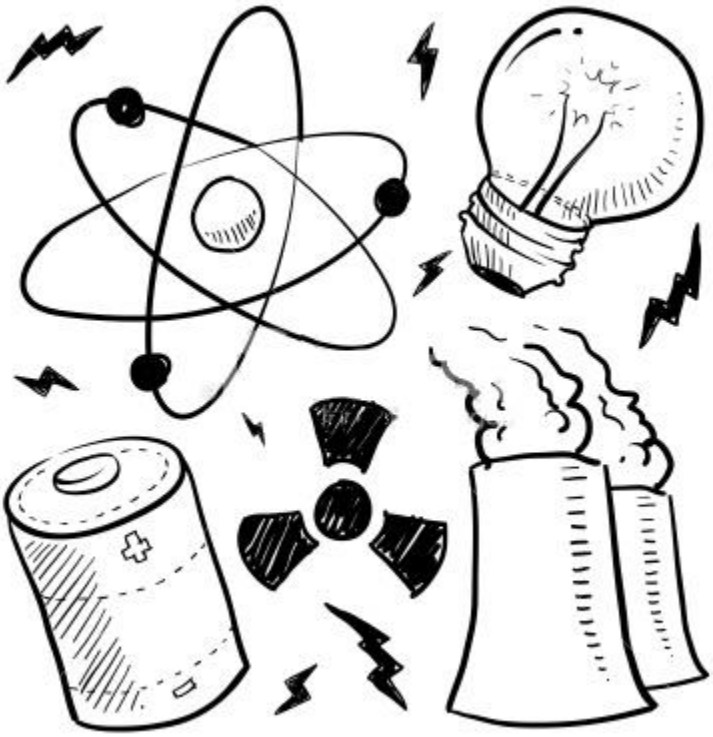
Galashiels Academy

National 5 Physics



Radiation & Waves

Consolidation and Revision Questions

Name:	**Class:**

Radiation and Waves Questions		Date Due	Mark
1	Wave Properties		/20
2	Wave Speed		/20
3	Wave Equation		/20
4	Sound Waves		/20
5	Electromagnetic Spectrum		/20
6	Diffraction		/20
7	Refraction		/20
8	Focal Length		/20
9	Properties of Radiation		/20
10	Activity		/20
11	Half Life		/20
12	Absorbed Dose & Equivalent Dose		/20
13	Nuclear Fission & Fusion		/20

DATA SHEET

Speed of light in materials

Material	*Speed* in m/s
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	$2{\cdot}3 \times 10^8$

Speed of sound in materials

Material	*Speed* in m/s
Aluminium	5200
Air	340
Bone	4100
Carbon dioxide	270
Glycerol	1900
Muscle	1600
Steel	5200
Tissue	1500
Water	1500

Gravitational field strengths

	Gravitational field strength on the surface in N/kg
Earth	10
Jupiter	26
Mars	4
Mercury	4
Moon	1·6
Neptune	12
Saturn	11
Sun	270
Venus	9

Specific heat capacity of materials

Material	*Specific heat capacity* in J/kg °C
Alcohol	2350
Aluminium	902
Copper	386
Glass	500
Ice	2100
Iron	480
Lead	128
Oil	2130
Water	4180

Specific latent heat of fusion of materials

Material	*Specific latent heat of fusion* in J/kg
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	$3{\cdot}34 \times 10^5$

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

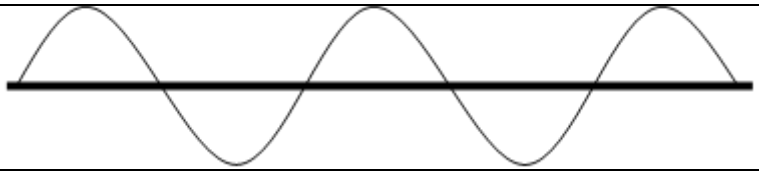
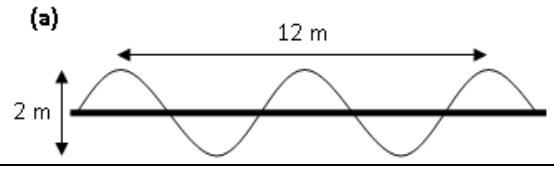
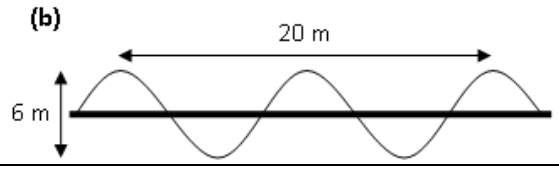
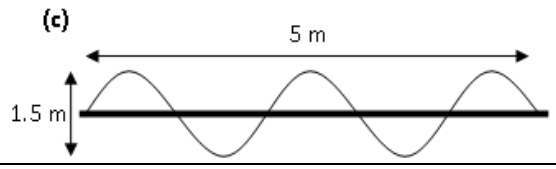
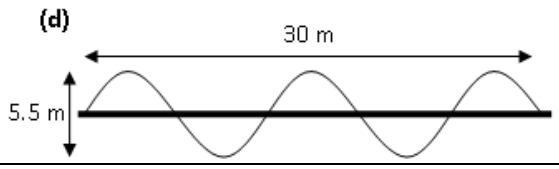
Specific latent heat of vaporisation of materials

Material	*Specific latent heat of vaporisation* in J/kg
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	$22{\cdot}6 \times 10^5$

Radiation weighting factors

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

Exercise 1: Wave Properties

1.	Copy and complete this sentence: _____ can be transferred from one place to another as waves.	**1**
2.	What is the meaning of the term 'transverse' when describing waves?	**1**
3.	What is the meaning of the term 'longitudinal' when describing waves?	**1**
4.	Copy this diagram of a wave and label the following: *Wavelength, Amplitude, Crest, Trough, Axis*	**5**
		
5.	Describe the following properties of waves	**4**
	a) Wavelength	
	b) Frequency	
	c) Amplitude	
	d) Wave speed	
6.	Water waves are represented in these diagrams. Calculate the wavelength and amplitude of each wave.	**8**
	 	
	 	
		Total 20

Exercise 2: Wave Speed

1. Copy and complete the table **6**

	Speed / m s^{-1}	*Distance* / m	*Time* / s
(a)		50	20
(b)		280	1120
(c)	12		0.8
(d)	340		3.5
(e)	6.8	272	
(f)	95	475	

2. A water wave travels along the length of a 25 metre swimming pool in 6.25 seconds. What is the speed of the water wave? **2**

3. A wave moves along a slinky with a speed of 0.75 m s^{-1}. The wave travels the full length of the slinky in 3.2 seconds. How long is the slinky? **2**

4. A seismic wave travels through the ground at 2.5 km s^{-1} after an earthquake. How long does it take the wave to travel 45 km? **2**

5. A water wave travels with a speed of 4 m/s for 2 minutes. How far does it travel? **2**

6. A wave travels through a wire at 1.5 km s^{-1} . How long does it take the wave to travel 5 m? **2**

7. A water wave travels 25 cm in 10 seconds. What is the speed of the water wave? **2**

8 A wave travels 300 mm in 1 minute. What is the speed of the wave? **2**

Total 20

Exercise 3: Wave Equation

1 Copy and complete the table **6**

	Speed / m s^{-1}	*Frequency* / Hz	*Wavelength* / m
(a)		800	4
(b)		40 000	0.0085
(c)	5		0.25
(d)	690		2.3
(e)	45	15	
(f)	180	750	

2 What is the speed of a water wave that has a frequency of 0.5 Hz and a wavelength of 3.6 metres? **2**

3. A wave moving through water has a speed of 2.8 m/s and a wavelength of 7.0 cm. What is the frequency of the wave? **2**

4. A wave of frequency 40 Hz has a speed of 20 m s^{-1} in a gel. What is the wavelength of the wave? **2**

5. A sound wave of frequency 8.5 kHz has a speed of 340 m s^{-1} in air. What is the wavelength of the wave? **2**

6. A wave travels along a 0.5 km harbour in 40 s. A lifeguard counts that 80 waves pass him in this time

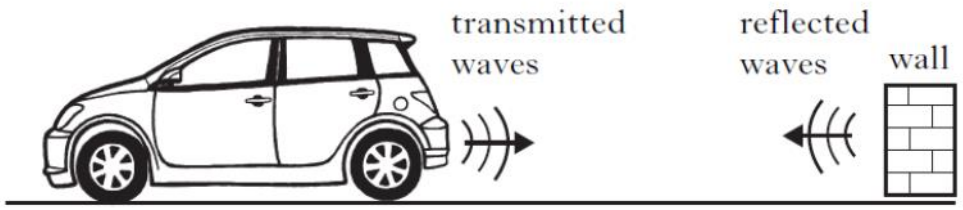
a) What is the frequency of the wave? **2**

b) What is the wave speed? **2**

c) Calculate the wavelength of the wave. **2**

Total 20

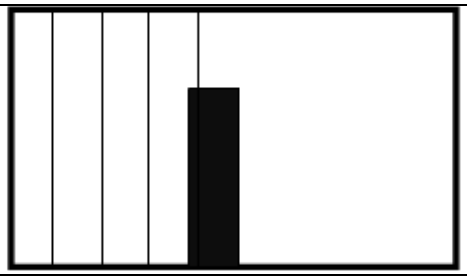
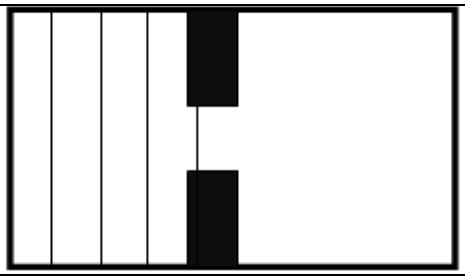
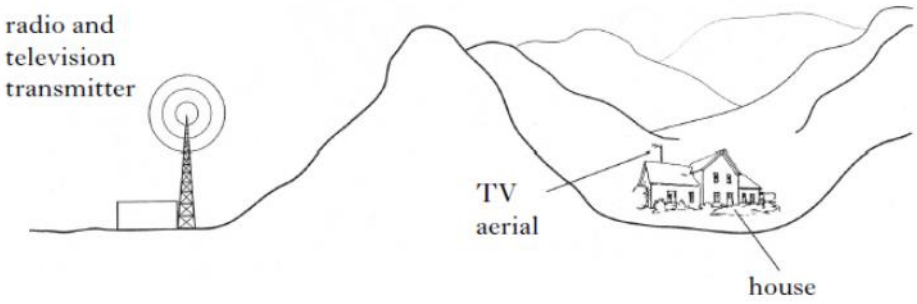
Exercise 4: Sound Waves

1.	Describe how you would measure the speed of sound in air using the following equipment: *An electronic timer, 2 microphones, a metre stick, a bottle and a knife.* Include in your description all the measurements you would take and state the instruments you would use to measure them.		**3**
2.	a)	State the speed of sound in air	**1**
	b)	How far will a sound wave travel through air in 5 seconds?	**2**
	c)	A sound wave has a frequency of 800 Hz. What is it's wavelength?	**2**
3.	An ultrasound sound wave from a dolphin travels through water with a wavelength of 3 cm. The wave travels a distance of 150 metres to a second dolphin.		
	a)	How long does it take the ultrasound wave to reach the second dolphin?	**2**
	b)	What is the frequency of the ultrasound wave?	**2**
4.	A car is fitted with a parking system. This warns how close objects are behind the car. Equipment on the back of the car sends out ultrasound waves and receives the reflected waves.		**2**
			**2**
	There is a 5 ms gap between a wave been transmitted and received. How far away is a wall from the back of the car?		
5.	State two other uses for ultrasounds in industry or medicine.		**2**
6.	Explain why there is a delay between seeing lightning and hearing thunder.		**2**
		Total 20	

Exercise 5: Electromagnetic Spectrum

1.	Write out the EM spectrum in order of **increasing** wavelength			**2**
2.	State the speed of an EM wave in a vacuum			**2**
3.	Describe what happens to the energy and wavelength of an EM wave as the frequency increases.			**2**
4.	Describe an application of each of these types of electromagnetic radiation in medicine:			**4**
	a)	X-rays		
	b)	Gamma Rays		
	c)	Infrared Radiation		
	d)	Ultraviolet Radiation		
5.	Describe an application of each of these types of electromagnetic radiation in the home			**2**
	a)	Infrared Radiation		
	b)	Microwaves		
6.	Why are gamma rays unsuitable for using in mobile phone communication? Give two reasons for your answer			**2**
7.	How long will it take visible light to travel through 250 km of water?			**2**
8.	A radio carrier wave is sent out from BBC Radio 1 in London with a frequency of 97.5 MHz. A student in Edinburgh (which is 670 km away) is listening to the broadcast.			
		What is the wavelength of this radio wave?		**2**
		How long will it take the wave to travel from London to Edinburgh?		**2**
				Total 20

Exercise 6: Diffraction

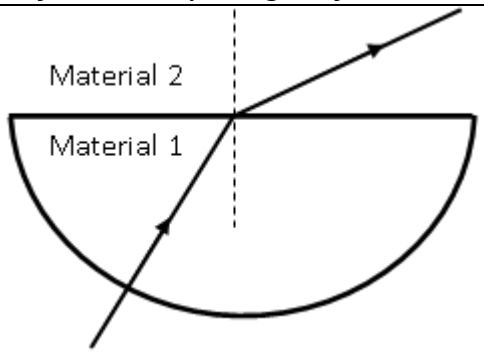
1.	What is meant by Diffraction?			**2**
2.	Copy and complete these diagrams to show water waves bending around an obstacle			**2**
	(a)  (b) 			
3.	A hill lies between a radio and television transmitter and a house. The house is within the range of both the radio and television signals from the transmitter			
				
	a)	The house has good radio reception but poor television reception. Suggest an explanation for this.		**2**
	b)	A mobile phone transmitter emits microwaves and is attached to the existing transmitter. Predict whether the mobile phone reception will be good or poor in the house. Give a reason for your answer.		**2**
	c)	Explain why you cannot watch TV but the picture from a DVD playing in the houseis perfect		**2**
4.	Kate has gone to see Green Day in London: her seat is only 150m from the stage. Her brother John is in Kelso listening to it live on Radio One. Who will hear the music first? Explain your answer.			**4**
5.	1) FM radio stations broadcast at a higher frequency than MW. Victoria lives in a deep valley, her radio designed to pick up both FM and MW but she can only listen to broadcasts carried by one type of wave.			
	a)	Which broadcast does Victoria listen to?		**2**
	b)	Explain why she receives this broadcast but not the other.		**2**
			Total 20	

Exercise 7: Refraction

1. What is meant by the term *refraction*? **1**

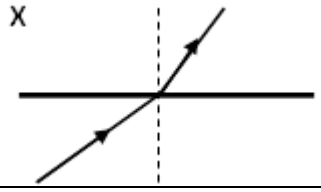
2. Copy this diagram and label it with the following: **5**

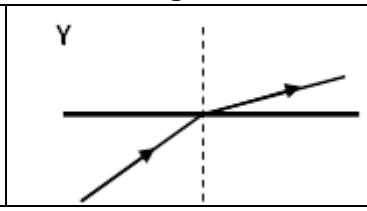
Incident ray, Refracted ray, Angle of incidence, Angle of refraction, Normal.

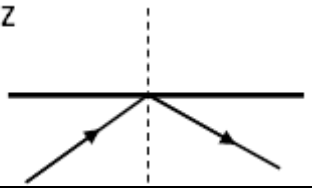


3. Which of these diagrams shows what happens when a ray of light: **4**

- travels from air in to glass at an angle above the critical angle of glass?
- travels from glass in to air at an angle above the critical angle of glass?
- travels from air in to water at an angle less than the critical angle of water?
- travels from water in to air at an angle less than the critical angle of water?



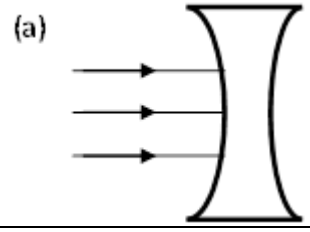


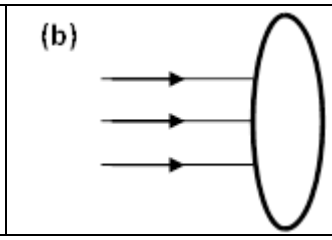


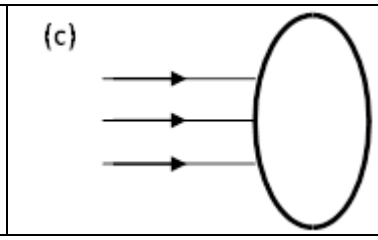
4. A student is given a Perspex block, a pencil, a protractor, a ruler, a piece of blank A4 paper, a ray box and a power supply. **2**

Describe how the student could use this equipment to find the critical angle of Perspex.

5. Copy and complete these diagrams to show the effect the lenses have on parallel incident rays of light. **6**







2

Total 20

Exercise 8: Focal Length

1. A student makes the following statement: **2**

"The focal length of a convex lens is 15 cm."

What is the meaning of this statement?

2. Calculate the focal lengths of convex lenses with the following powers: **6**

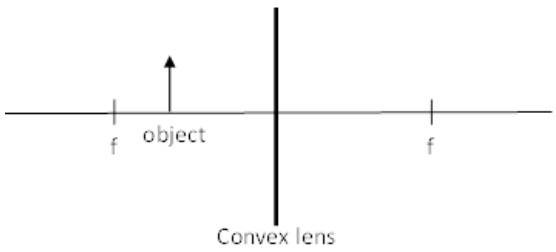
a. + 4.5 D

b. + 1.5 D

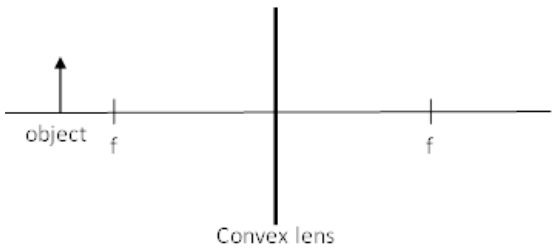
c. + 5.0 D

3. Copy and complete these ray diagrams to show the image produced. **6**

(a)



(b)



For each ray diagram, state whether the image is:

- Real or virtual.
- Magnified or diminished.
- Upright or inverted.

4. State what is the meant by the following eye defects and state the lens needed to correct each.

a. Short sighted **2**

b. Long sighted **2**

5. A lifeguard is looking at a swimmer in a pool. Explain, with the aid of a diagram, why the lifeguard sees the swimmer at point B rather than her actual position at point A? **2**

Total 20

Exercise 9: Properties of Radiation

1. Describe what the following radiations are made up of. **3**

a) Alpha

b) Beta

c) Gamma

2. What is the meaning of the term 'ionisation'? **1**

3. Copy and complete this table to show the properties of radiation. **3**

	Properties			
Radiation	**Symbol**	**Size**	***Charge***	***Stopped by …***
Alpha				
Beta				
Gamma				

4. Give two safety precautions that should be followed when working with radioactive materials. **1**

5. a) What is background Radiation **1**

b) Name three main sources of Background Radiation **1**

c) Is background radiation mostly man-made or natural? **1**

6. What effect does radiation have on living cells? **1**

7. Smoke alarms are made with an alpha source (Americium-241). Describe how a smoke alarm uses ionisation to warn people of a possible fire. **2**

8. A radioactive tracer is a gamma emitting chemical compound that can be injected in to a patient in hospital. Describe how this can be useful in diagnosis of medical problems. **2**

9. Gamma rays can also be used to treat cancer in a method known as radiotherapy. Describe how a patient can have a cancer treated in this way, and how damage to surrounding healthy tissue is minimised. **2**

10 The following equipment can be used to detect radiation. Choose one piece of equipment and describe how it detect radiation. **2**

Geiger-Muller Tube, Film Badge, Scintillation Counter

Total 20

Exercise 10: Activity

1 Copy and complete this table **6**

	Activity / Bq	*Number of Decays*	*Time* / s
(a)		720	60
(b)		4500	180
(c)	1000		100
(d)	12 500		500
(e)	40 000	3.0×10^{7}	
(f)	2.5×10^{6}	5.0×10^{8}	

2. What is meant by the 'activity' of a source? **1**

3. What is meant by the term 'radioactive decay'? **1**

4. What is the activity of a source that has 210 decays in a minute? **2**

5. A source has an activity of 2000 Bq. How many decays will occur in 30 seconds? **2**

6. A source has an activity of 2.0 kBq. How many counts will be recorded from the source by a Geiger-Muller tube (and counter) in 1 minute? **2**

7. How long will it take a source with an activity of 1.8 MBq to have 8.1×10^{8} radioactive decays?

8. Describe an experiment to find the activity of a radioactive source using the following equipment: **2**

Stopwatch, Geiger-Muller Tube, Counter.

9. In a laboratory, the background activity is measured as 1.5 Bq. A Geiger-Muller tube is used to measure the activity of a source in the laboratory. In three minutes, 1440 counts are recorded. What is the activity of the source? **2**

Total 20

Exercise 11: Half Life

1. What happens to the activity of a source as it gets older? **1**

2. What is the meaning of this statement? **2**

"The half-life of a radioactive source is 12 hours"

3. A radioactive material has a half life of 8 hours. If it has an original activity of 200 kBq, what is the activity of the source a day later **2**

4. The activity of a radioactive substance drops from 100 MBq to 6.25 MBq in 12 years. What is the half life of the substance? **2**

5. A material with a half life of 4 hours has an activity of 15 Bq at this moment. What was its activity 24 hours ago? **2**

6. A patient in a hospital is being given a radioactive tracer to find a blockage in his kidneys. The tracer is prepared in a laboratory with an initial activity of 16 kBq. It can't be safely given to the patient until the activity drops to 0.25 kBq. The half life of the tracer is 6 hours, and the patient is due to be treated at 9am on Saturday. When should the tracer be prepared? **2**

7. Describe how a student could calculate the half-life of a radioactive source using: **3**

a stopwatch, a clock, a detector and *a radioactive source*

8. In a science classroom, the background count is 2.0 Bq. The measured activity of a source at different times is recorded in this table. Draw an activity-time graph and use it to calculate the half-life of the source. **4**

***Time* / mins**	0	5	10	15	20	25	30	35
***Activity Recorded* / Bq**	66	51	43	34	27	22	18	15

9. A radiotherapist in a hospital has to decide which of five materials is to be used as a radioactive tracer. The materials and some of their properties are listed. Which material should the radiotherapist use? Give two reasons for your answer. **2**

Material	***Radiation Emitted***	***Half Life***
A	Alpha	4 hours
B	Gamma	3 hours
C	Beta	10 hours
D	Gamma	63 years
E	Alpha	5 minutes

Total 20

Exercise 12: Absorbed Dose & Equivalent Dose

1 Copy and complete this table **4**

	Absorbed Dose / Gy	*Energy*/ J	*Mass* / kg
(a)		6×10^{-6}	0.5
(b)		3.5×10^{-5}	0.25
(c)	8.8×10^{-5}		0.05
(d)	6.5×10^{-5}		0.26

2. What is the meaning of the term '*absorbed dose*'? **1**

3. What is the absorbed dose of a 400 g hand that absorbs 7 μJ of alpha particles? **2**

4. What is the mass of skin exposed to radiation with 4.2 μJ of energy if the absorbed dose is 10 μGy? **2**

5. A tumour of mass 150 g is exposed to gamma rays. The absorbed dose from this exposure is 5.1×10^{-5} μGy. What is the energy of the gamma rays absorbed by the tumour? **2**

6. Copy and complete this table **4**

	Equivalent Dose /Sv	*Absorbed Dose* / Gy	*Radiation Weighting Factor*
(a)		4.2×10^{-6}	1
(b)		1.7×10^{-5}	3
(c)	6.8×10^{-5}		10
(d)	4.5×10^{-5}	1.5×10^{-5}	

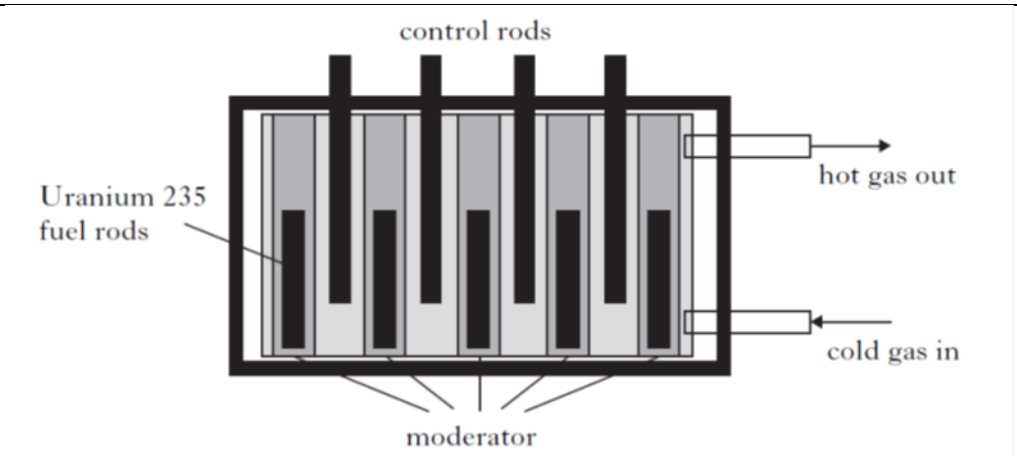
7. What is the meaning of the term '*equivalent dose*'? **1**

8. What is the equivalent dose of a patient's tissue, if it is exposed to 1.5 μGy of slow neutrons? **2**

9. What is the absorbed dose of a patient's foot, if it's equivalent dose is 0.4 mSv of gamma rays? **2**

Total 20

Exercise 13: Nuclear Fission & Fusion

1.	What is nuclear fission? (Draw a diagram to help you explain)	**2**
2.	What is a chain reaction in nuclear fission?	**2**
3.	How does a fission reaction create heat energy?	**1**
4.	Describe the purpose of each of these parts of a nuclear reactor: *Gas, Control Rods, Containment Vessel, Graphite Moderator, Uranium Rods*	**5**
		
5.	How is the heat energy from a nuclear reactor used to generate electricity?	**2**
6.	What is nuclear fusion? (Draw a diagram to help you explain)	**2**
7.	There is much debate in the UK about using nuclear power to generate electrical energy. Construct a table that shows the advantages and disadvantages of using nuclear energy to power the country.	**6**
	Total 20	