2013 Physics

Intermediate 2

Finalised Marking Instructions

Part One: General Marking Principles for Physics Intermediate 2

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question.

(b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

GENERAL MARKING ADVICE: Physics Intermediate 2

The marking schemes are written to assist in determining the "minimal acceptable answer" rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates' evidence, and apply to marking both end of unit assessments and course assessments.

Physics – Marking Issues

The current in a resistor is 1·5 amperes when the potential difference across it is 7·5 volts. Calculate the resistance of the resistor.

	Answers	**Mark + Comment**	**Issue**
1.	$V = IR$ $7{\cdot}5 = 1{\cdot}5R$ $R = 5{\cdot}0\ \Omega$	(½) (½) (1)	Ideal answer
2.	$5{\cdot}0\ \Omega$	(2) Correct answer	GMI 1
3.	5·0	(1½) Unit missing	GMI 2 (a)
4.	$4{\cdot}0\ \Omega$	(0) No evidence/wrong answer	GMI 1
5.	_____ Ω	(0) No final answer	GMI 1
6.	$R = \frac{V}{I} = \frac{7{\cdot}5}{1{\cdot}5} = 4{\cdot}0\ \Omega$	(1½) Arithmetic error	GMI 7
7.	$R = \frac{V}{I} = 4{\cdot}0\ \Omega$	(½) Formula only	GMI 4 and 1
8.	$R = \frac{V}{I} =$ _____ Ω	(½) Formula only	GMI 4 and 1
9.	$R = \frac{V}{I} = \frac{7{\cdot}5}{1{\cdot}5} =$ _____ Ω	(1) Formula + subs/No final answer	GMI 4 and 1
10.	$R = \frac{V}{I} = \frac{7{\cdot}5}{1{\cdot}5} = 4{\cdot}0$	(1) Formula + substitution	GMI 2 (a) and 7
11.	$R = \frac{V}{I} = \frac{1{\cdot}5}{7{\cdot}5} = 5{\cdot}0\ \Omega$	(½) Formula but wrong substitution	GMI 5
12.	$R = \frac{V}{I} = \frac{75}{1{\cdot}5} = 5{\cdot}0\ \Omega$	(½) Formula but wrong substitution	GMI 5
13.	$R = \frac{I}{V} = \frac{7{\cdot}5}{1{\cdot}5} = 5{\cdot}0\ \Omega$	(0) Wrong formula	GMI 5
14.	$V = IR$ $7{\cdot}5 = 1{\cdot}5 \times R$ $R = 0{\cdot}2\ \Omega$	(1½) Arithmetic error	GMI 7
15.	$V = IR$ $R = \frac{I}{V} = \frac{1{\cdot}5}{7{\cdot}5} = 0{\cdot}2\ \Omega$	(½) Formula only	GMI 20

2013 Physics Intermediate 2

Marking scheme

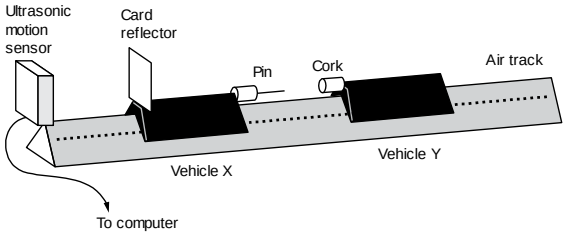
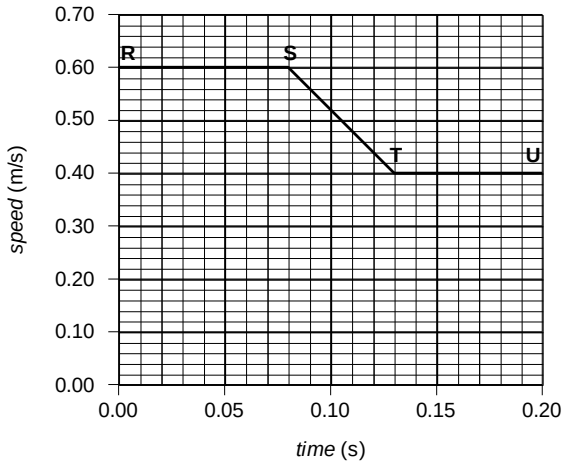
Section A

1.	B	11.	B
2.	D	12.	C
3.	E	13.	B
4.	D	14.	E
5.	E	15.	D
6.	A	16.	B
7.	D	17.	C
8.	A	18.	E
9.	A	19.	A
10.	C	20.	C

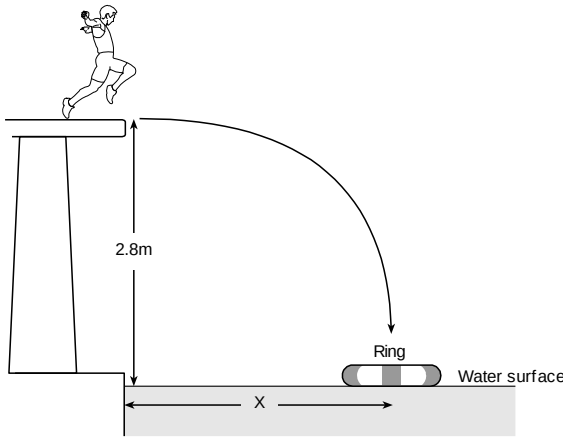
Part Two: Marking Instructions for each Question

Section B

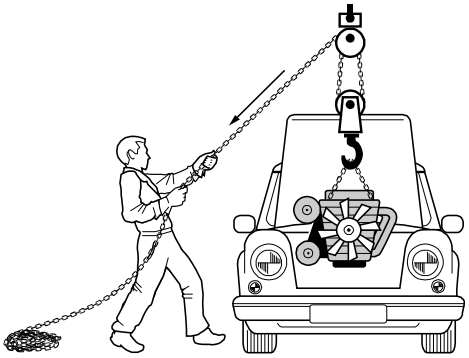
Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
21			A plane of mass 750 kg is at rest on a runway. The engine applies a force of 4·50 kN. 			
	(a)		Calculate the magnitude of the acceleration of the plane assuming there are no other forces acting on the plane at this point. $F = ma$ *(½)* $4500 = 750 \times a$ *(½)* $a = 6\ m/s^2$ *(1)*		**2**	
	(b)		The required speed for take-off is 54 m/s. Calculate the time it takes to reach this speed assuming the acceleration is constant. $a = \frac{v - u}{t}$ *(½)* $6 = \frac{54 - 0}{t}$ *(½)* $t = 54 \div 6$ $t = 9\ s$ *(1)*	Must be consistent with (a) Don't accept secs	**2**	
	(c)		In practice the acceleration is not constant. Give a reason for this. **Other forces will act on the plane (e.g. drag)** **Mass decrease (fuel consumption)**		**1**	**5**

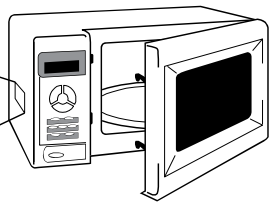
Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
22			A student uses a linear air track and an ultrasonic motion sensor to investigate a collision between two vehicles.  Vehicle Y is at rest before the collision. Vehicle X is given a push and then released. A pin on vehicle X sticks into a cork on vehicle Y causing them to join and move off together. The motion sensor measures the speed of vehicle X every 0·01 s. The graph shows the results obtained from the investigation after vehicle X has been released.  			
	(a)		State the speed of ultrasonic waves in air. **340 m/s (from datasheet)**	1 or 0 no half marks Must have unit	**1**	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
	(b)	**(i)**	Describe the motion of vehicle X between points **S** and **T**. **(Constant) <u>negative</u> acceleration** ***(1)***	Accept deceleration and "slowing down" Do not accept decelerating at a constant speed	**1**	
		(ii)	Calculate the distance travelled by vehicle X between points **S** and **T**. **Distance = area under graph** ***(½)*** **Distance = (0·05 × 0·4) + (0·5 × 0·05 × 0·2)** ***(½)*** **Distance = 0·02+ 0·005** **Distance = 0·025** **Distance = 0·025 m** ***(1)***	Average speed method is OK. $v = \frac{d}{t}$ $0.5 = \frac{d}{0.05}$ d = 0.025 m	**2**	
		(iii)	Vehicle X has a mass of 0·50 kg. Use the law of conservation of momentum to show that vehicle Y has a mass of 0·25 kg. **<u>TMB = TMA statement</u>** ***(½)*** **Momentum Before 0·50 × 0·60 = 0·30** ***(½)*** **Momentum After 0·75 × 0·40 = 0·30** ***(1)***	(Total) momentum before = (Total) momentum after **Or** $m_1v_1 = m_2v_2$ ***(½)*** ***(½)*** ***(1)*** $0·50 \times 0·6 = (0·5 + m_B) \times 0·4$ $m_B = 0·25$ kg (Given)	**2**	
		(iv)	**A** Calculate the kinetic energy lost in this collision. $E_k = ½ mv^2$ ***(½)*** **Before** $= ½ \times 0·5 \times 0·6^2 = 0·09$ ***(½)*** **After** $= ½ \times 0·75 \times 0·4^2 = 0·06$ ***(½)*** **Loss** $= 0·09 – 0·06$ ***(½)*** $= 0·03$ **J** ***(1)***		**3**	
			B What happens to the lost kinetic energy? **Turns into <u>heat</u> energy (in pin/cork)**	Sound alone 0	**1**	**10**

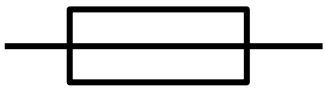
Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
23			In a TV game show contestants are challenged to run off a horizontal platform and land in a rubber ring floating in a swimming pool. The platform is 2·8 m above the water surface.  			
	(a)		A contestant has a mass of 60 kg. He runs off the platform with a horizontal velocity of 2 m/s. He takes 0·75 s to reach the water surface in the centre of the ring.			
		(i)	Calculate the horizontal distance X from the poolside to the centre of the ring. $d = vt$ *(½)* $d = 2 \times 0{\cdot}75$ *(½)* $d = 1{\cdot}5$ m *(1)*		**2**	
		(ii)	Calculate the vertical velocity of the contestant as he reaches the water surface. $a = \frac{v - u}{t}$ *(½)* $10 = \frac{v - 0}{0 \cdot 75}$ *(½)* $v = 7{\cdot}5$ m/s *(1)*	If 9.8 used 7.35, 7.4 If 9.81 used 7.358, 7.36, 7.4	**2**	

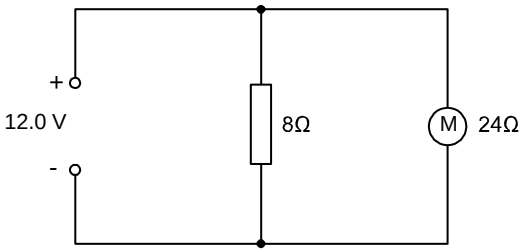
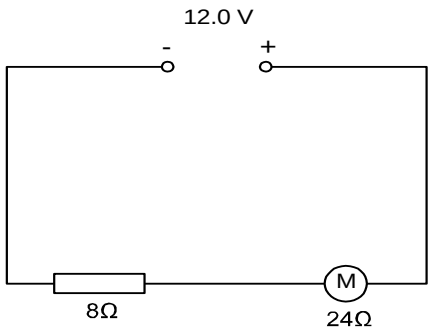
Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
	(b)		Another contestant has a mass of 80 kg. Will she need to run faster, slower or at the same horizontal speed as the first contestant to land in the ring? You **must** explain your answer. **Same** ***(1)*** **All objects fall with the same (vertical) acceleration.** ***(1)***	Must have explanation to get first mark Will take the same time to reach the water	**2**	**6**

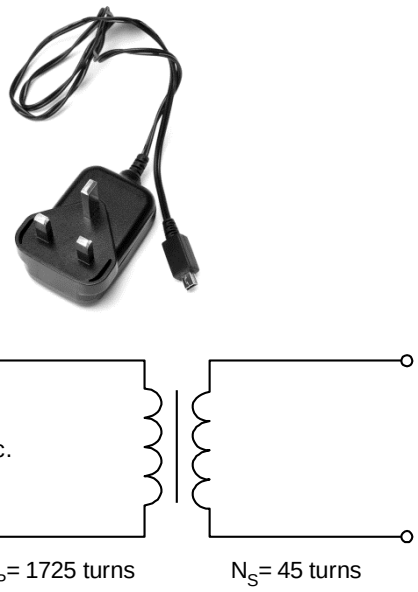
Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
24			In a garage, a mechanic lifts an engine from a car using a pulley system. 			
	(a)		The mechanic pulls 4·5 m of chain with a constant force of 250 N. Calculate the work done by the mechanic. $E_w = Fd$ *(½)* $E_w = 250 \times 4{\cdot}5$ *(½)* $E_w = 1125$ J *(1)*		**2**	
	(b)		The engine has a mass of 144 kg and is raised 0·75 m. Calculate the gravitational potential energy gained by the engine. $E_p = mgh$ *(½)* $E_p = 144 \times 10 \times 0{\cdot}75$ *(½)* $E_p = 1080$ J *(1)*	9·8(1) for 'g' OK 1058 (1059) 1100	**2**	
	(c)		Calculate the percentage efficiency of the pulley system. $\text{percentage efficiency} = \frac{\text{useful } E_o}{E_i} \times 100$ *(½)* $\text{percentage efficiency} = \frac{1080}{1125} \times 100$ *(½)* $\text{percentage efficiency} = 96\%$ *(1)*	Must be consistent with (a) and (b) (94% if 9·8(1) used)	**2**	**6**

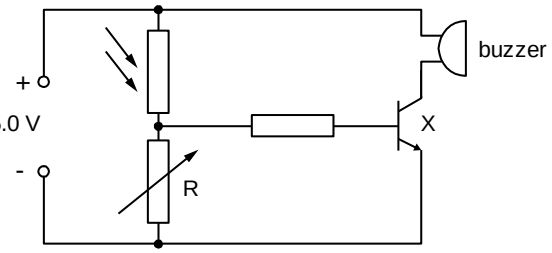
Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
25			The rating plate on a microwave oven shows the following data. **Rating Plate** Voltage = 230V a.c. Input electrical power = 1196W Ouput microwave power = 700W Microwave frequency = 2500 MHz 			
	(a)		State what is meant by the term voltage. **(The voltage of a supply is a measure of) the energy given to the charges in a circuit.** ***(1)***	Don't accept energy per electron Do accept: energy given to electrons energy per coulomb energy per charge	**1**	
	(b)	**(i)**	Calculate the input current. $I = P/V$ ***(½)*** $= 1196/230$ ***(½)*** $= 5{\cdot}2$ **A** ***(1)***	Accept Amps	**2**	
		(ii)	The microwave is used to heat a cup of milk for 1 minute 30 seconds. Calculate how much electrical charge passes through the flex in this time. $Q = It$ ***(½)*** $= 5{\cdot}2 \times (60 + 30)$ ***(½)*** $= 468$ **C** ***(1)***	Must be consistent with (b) (i)	**2**	
		(iii)	The milk of mass 0·25 kg absorbs 48 kJ of energy during the heating process. The specific heat capacity of milk is 3900 J/kg ºC. Calculate the temperature rise in the milk. $E = mc\Delta T$ ***(½)*** $48000 = 0{\cdot}25 \times 3900 \times \Delta T$ ***(½)*** $\Delta T = 49{\cdot}2^{\circ}$ **C** ***(1)***	49, 50, 49.23	**2**	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
	(c)		Calculate the wavelength of the microwaves. $\lambda = v/f$ *(½)* $= 3 \times 10^8/2500 \times 10^6$ *(½)* **= 0·12 m** *(1)*		**2**	**9**

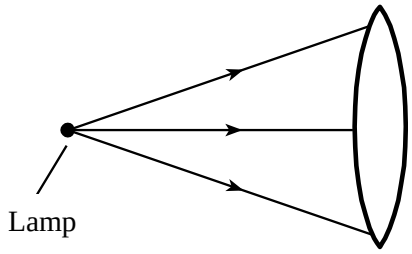
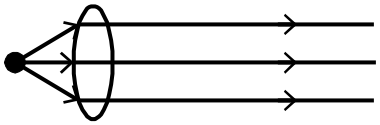
Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
26			An overhead projector contains a lamp and a motor that operates a cooling fan. A technician has a choice of two lamps to fit in the projector. **Lamp A**: rated 24·0 V, 2·5 Ω **Lamp B**: rated 24·0 V, 5·4 Ω 			
	(a)		Which lamp gives a brighter light when operating at the correct voltage? Explain your answer. **Lamp A** ***(1)*** **It has the lowest resistance/highest current/greatest power** ***(1)***	one of three	**2**	
	(b)		Calculate the power developed by lamp A when it is operating normally. $P = V^2/R$ ***(½)*** $= 24^2/2{\cdot}5$ ***(½)*** **= 230 W** ***(1)***	V = I R and P = I V (½) (I = 9.6 A) 230·4 W	**2**	
	(c)		The overhead projector plug contains a fuse. Draw the circuit symbol for a fuse. 		**1**	

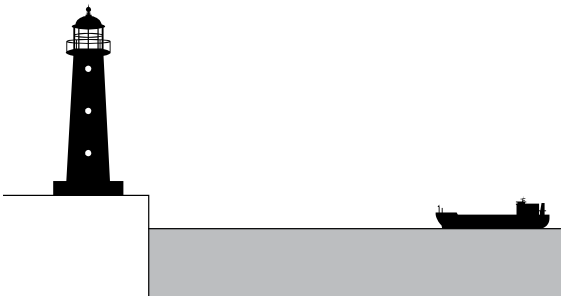
Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
	(d)		The technician builds a test circuit containing a resistor and a motor, as shown in **Circuit 1**.  **Circuit 1**			
		(i)	State the voltage across the motor. **12 V**	1 or 0 unit required	**1**	
		(ii)	Calculate the combined resistance of the resistor and the motor. **$1/R_p = 1/R_1 + 1/R_2$** ***(½)*** **$= 1/8 + 1/24$** ***(½)*** **$= 4/24$** **$R_p = 24/4$** **$= 6\ \Omega$** ***(1)***	-½ if rounding within calculation	**2**	
	(e)		The resistor and the motor are now connected in series, as shown in **Circuit 2**.  **Circuit 2** State how this affects the speed of the motor compared to **Circuit 1**. Explain your answer. **The motor speed will reduce** ***(1)*** **The (combined) resistance (of the circuit) is now higher/current is lower.** **Voltage across motor is less** **Motor has less power** ***(1)***	any one of four	**2**	**10**

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
27			A mains operated mobile phone charger contains a transformer. Part of the circuit is shown below.  The primary coil of the transformer has 1725 turns. The secondary coil has 45 turns.			
	(a)		Calculate the voltage across the secondary coil. $N_s/N_p = V_s/V_p$ *(½)* **45/1725 = V_s/230** *(½)* **V_s = 6 V** *(1)*		**2**	
	(b)		When the charger is connected to a mobile phone the output current is 0·80 A. Calculate the current in the primary coil. $I_p V_p = I_s V_s$ *(½)* **I_p × 230 = 0·80 × 6** *(½)* **I_p = (0·80 × 6)/230** **= 0·021 A or 21 mA** *(1)*	or $I_pN_s = I_sN_p$ must be consistent with (a) 0·02 A 0·021 A 0·0209 A	**2**	
	(c)		What is the frequency of the mains supply in the UK? **50 Hz**	-½ if no unit	**1**	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
	(d)		230 V a.c. is the quoted value of the mains supply in the UK. State how the quoted value compares with the peak value. **The quoted value is smaller than the peak value.**	Accept smaller on its own	**1**	**6**
28			A photographic darkroom has a buzzer that sounds when the light level in the room is too high. The circuit diagram for the buzzer system is shown below.  			
	(a)	**(i)**	Name component X. **X = (NPN) transistor**	0 marks for MOSFET or PNP transistor	**1**	
		(ii)	What is the purpose of component X in the circuit? **To act as a <u>switch</u>**	To turn on the buzzer 0 marks To operate the buzzer 0 marks	**1**	
	(b)		The darkroom door is opened and the light level increases. Explain how the circuit operates to sound the buzzer. **Resistance of <u>LDR</u> reduces *(½)*** **so voltage across <u>LDR</u> reduces *(½)*** **Voltage across <u>variable resistor/R</u> increases *(1)*** **When voltage across <u>variable resistor/R</u> reaches (0·7 V) transistor switches buzzer on. *(1)***	Accept 'when voltage is high enough'	**3**	

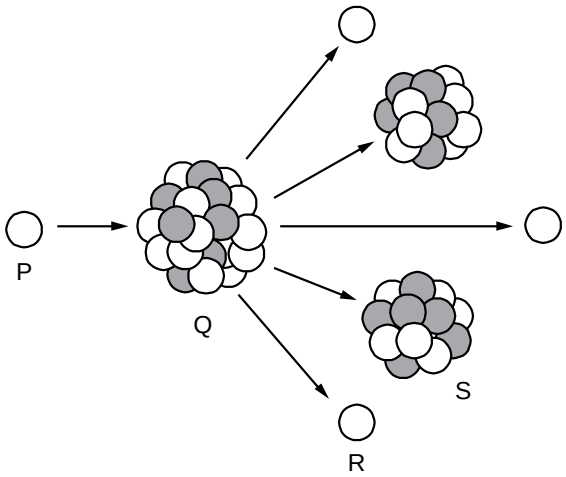
Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
	(c)		The table shows how the resistance of the LDR varies with light level. *Light level* (units) — *LDR Resistance* (Ω) 20 — 4500 50 — 3500 80 — 2500 The variable resistor has a resistance of 570 Ω. The light level increases to 80 units. Calculate the current in the LDR. **80 units: resistance of LDR = 2500 (Ω)** ***(½)*** **Total resistance = 2500 + 570** **= 3070 (Ω)** ***(½)*** --- ***I* = *V/R*** ***(½)*** **= 5/3070** ***(½)*** **= 1·63 × 10^{-3} A or 1·63 mA** ***(1)***	1·6 mA 1·63 mA 1·629 mA	**3**	
	(d)		What is the purpose of the variable resistor R in this circuit? **The variable resistor is to set the light level at which the transistor will switch on or to set the level at which the buzzer will sound**		**1**	**9**

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
29			A lighthouse uses a converging lens to produce a beam of light.  			
	(a)		The lamp is placed at the focal point of the lens. Copy and complete the diagram to show the paths of the light rays after they pass through the lens. 	ignore rays through lens rays must be parallel and straight – PJ -½ no arrows	**1**	
	(b)		The power of the lens is 6·25 D. Calculate its focal length. **focal length = 1/lens power** ***(½)*** **= 1/6·25** ***(½)*** **= 0·16 m** ***(1)***		**2**	
	(c)		The lamp flashes once every 7·5 seconds. What is the name given to the time between each flash? **The period** ***(1)***	Accept time period	**1**	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
	(d)		The lighthouse also uses a foghorn to alert ships. A ship is at a distance of 2·04 km from the lighthouse.  Calculate the time taken for the sound to reach the ship. ***d* = *v* × *t*** ***(½)*** **2040 = 340 × *t*** ***(½)*** ***t* = 2040/340** ***t* = 6 s** ***(1)***	6·0 s	**2**	
	(e)		Light waves are transverse waves. Sound waves are longitudinal waves. Describe each type of wave in terms of vibrations. **With <u>transverse</u> waves the vibrations are at <u>right angles</u> to the <u>direction</u> of travel.** ***(1)*** **With <u>longitudinal</u> waves the vibrations are in the <u>same direction</u> of travel.** ***(1)***		**2**	**8**

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
30	**(a)**		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. State what is meant by a radiation weighting factor. **A measure of the biological effect of a radiation.**	If stated harmful/damaging it must be qualified i.e. to living tissue or similar	**1**	
	(b)		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. $\mathbf{D = \frac{E}{m}}$ *(½)* $\mathbf{1 \cdot 5 \times 10^{-3} = \frac{E}{1 \cdot 4}}$ *(½)* $\mathbf{E = 2 \cdot 1 \times 10^{-3}\ J}$ *(1)*		**2**	
	(c)		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. **halving activity** *(½)* **3 times** *(½)* **Answer = 40 MBq** *(1)*	Accept other methods if correct **Answer not made clear – ½**	**2**	**5**

Time (hr)	**0**	**6**	**12**	**18**
Activity MBq	**320**	**160**	**80**	**40**

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
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.  			
		(i)	What type of nuclear reaction is shown in the diagram? **Fission**	Accept induced fission Chain reaction 0 marks Must be spelt correctly	**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. **P (slow) neutron** ***(½)*** **Q (fissionable) <u>nucleus</u>** ***(½)*** **R (fast) neutron** ***(½)*** **S fission fragment/daughter product** ***(½)***	<u>Smaller</u> <u>nucleus</u>	**2**	
	(b)		Name the part of the reactor whose function is to prevent release of radiation beyond the reactor. **Containment vessel**		**1**	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
	(c)		Disposal of some types of radioactive waste from nuclear reactors is particularly difficult. Give a reason for this difficulty. **Stays (highly) radioactive for a (very) <u>long time</u>** ***(1)***		**1**	
	(d)		Electricity can be generated using fossil fuels or nuclear fuel. State one advantage of using nuclear fuel. **Any correct answer** ***(1)*** **eg** **Much more energy per kg of fuel** **Does not produce greenhouse/acidic gases**	<u>Not</u> Cheaper Cleaner Renewable Efficient	**1**	**6**

[END OF MARKING INSTRUCTIONS]