Name: _____

Forces & Motion 2

Date:

Time: 53 minutes

Total marks available: 53

Total marks achieved: _____

Questions

Q1.

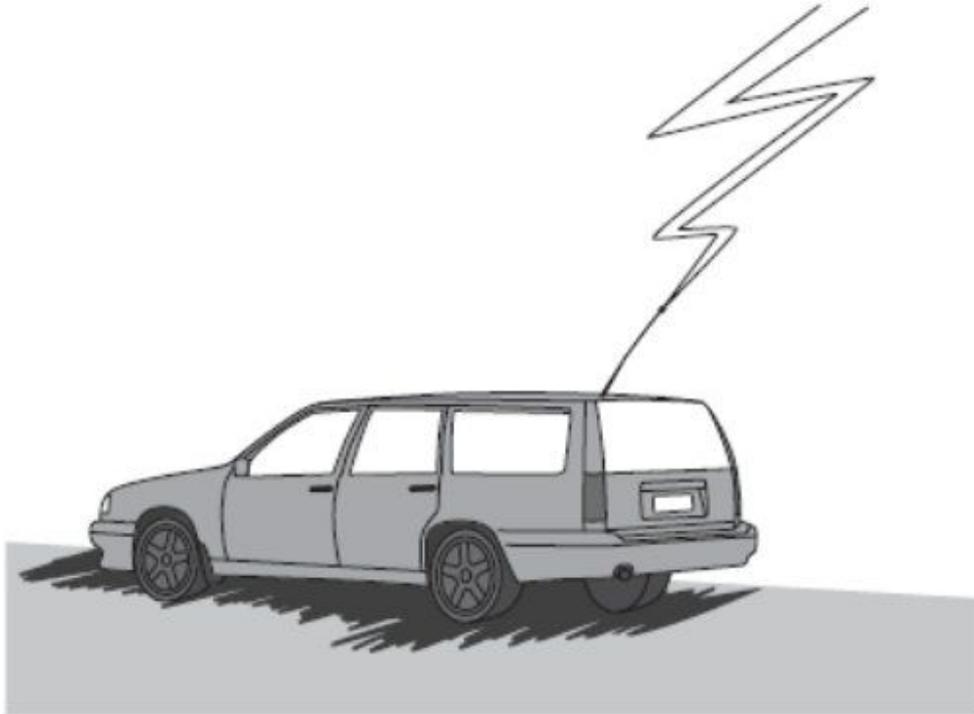In a science fiction story, lightning is used as an energy source for accelerating a car.

Figure 6

In the story, the car has a kinetic energy of 960 kJ at a speed of 40 m/s.

(i)   Calculate the mass of the car.

(4)

mass = ... kg

(ii) Only 5% of the energy of the lightning bolt is transferred to the kinetic energy of the car.

Calculate the total energy of the lightning bolt in MJ.

(2)

energy = ... MJ

(Total for question = 6 marks)

Q2.

Some students investigate a model of the craters produced by meteorite impacts.
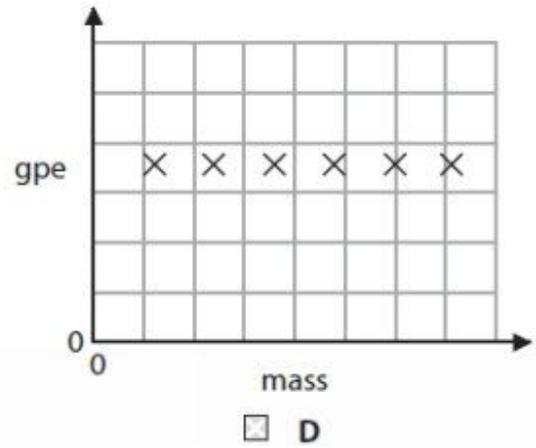
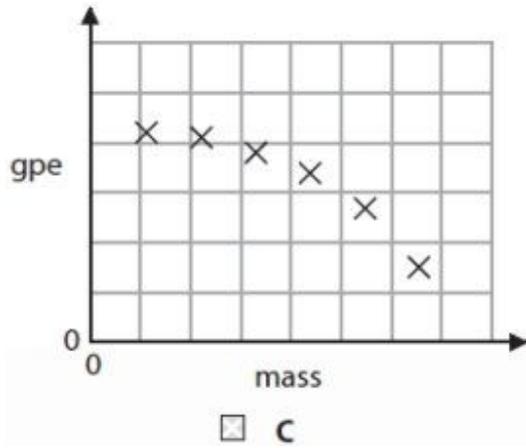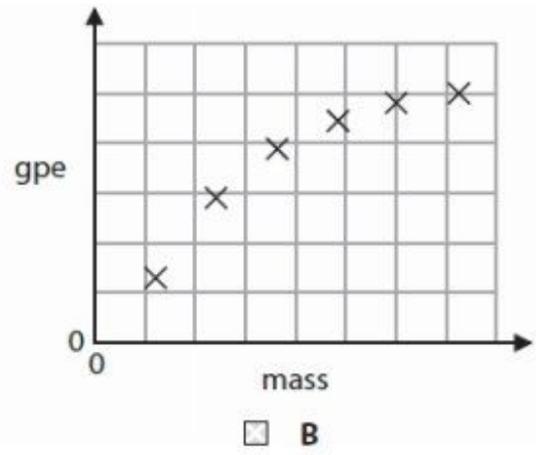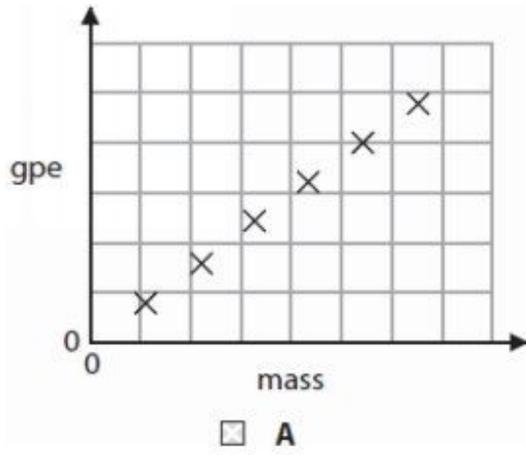They drop balls into a tray filled with sand.

They use six balls with different masses.

They drop each ball from the same height.

(a) (i) Which one of these graphs shows the relationship between the gravitational potential energy (gpe) of the balls and their mass when they are all at the same height?

Put a cross (☒) in the box next to your answer.

(1)

□ A

□ B

□ C

□ D

(ii) Describe how the energy of a ball changes as it drops towards the sand.

(2)

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(b) This photograph shows the sand after several balls have hit it.
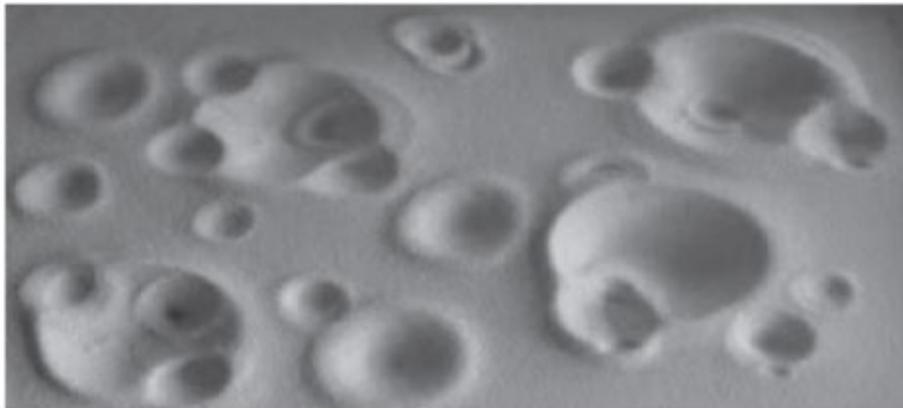
The students read this information in a textbook:

'When work is done, energy is transferred.'

Explain how work is done when the balls impact on the sand.

(2)

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(c) When one ball hits the sand, it has a velocity of 6.2 m/s.

It has a momentum of 0.46 kg m/s.
(i) Calculate the mass of the ball.

(3)

mass of ball = ... kg

(ii) The ball takes 0.17 s to come to rest after it hits the sand.
Calculate the average impact force.

(2)

average impact force = ... N

Q3.

A student investigates the motion of a trolley along a horizontal runway.

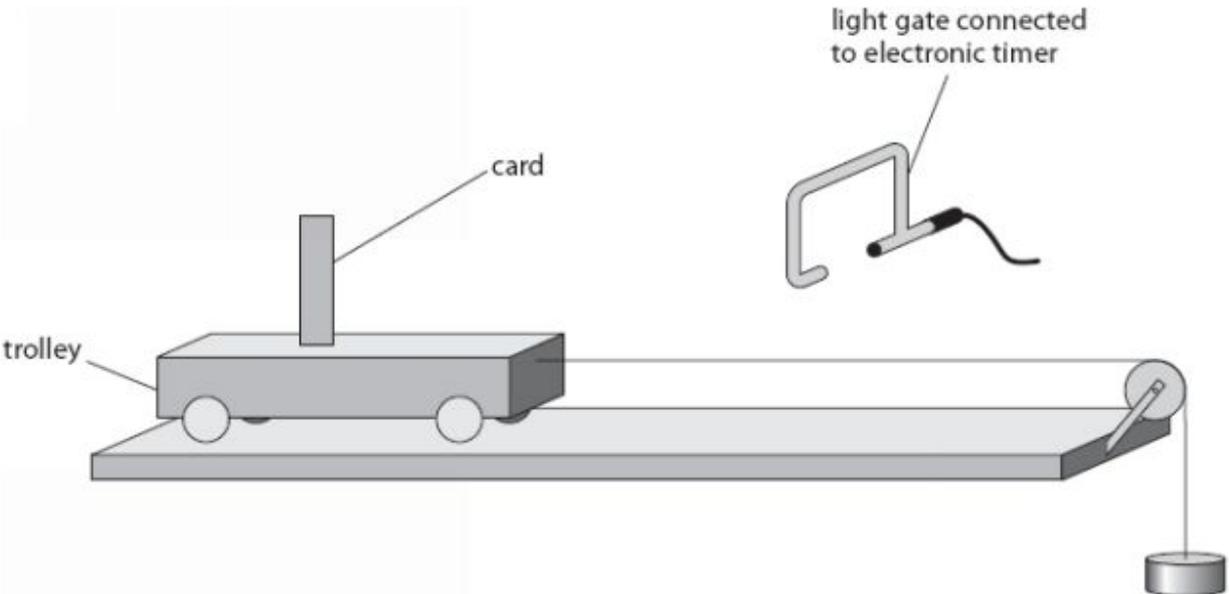Figure 9 shows the apparatus.

Figure 9

The trolley is attached to a string passing over a pulley.

A 100 g metal disc hangs on the end of the string.

The light gate measures the time it takes for the card to pass through it.

The student repeats the process several times by adding extra 100 g metal discs.
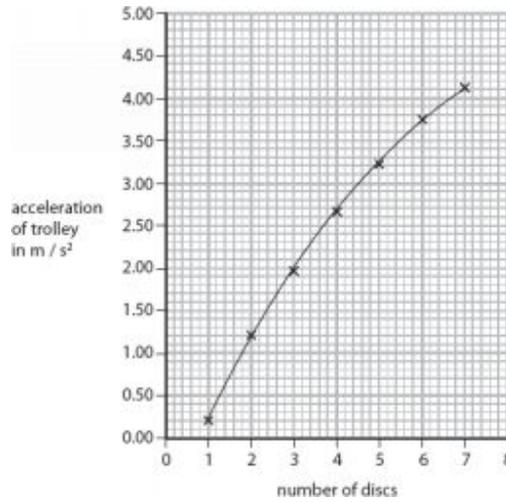
Figure 10 shows a graph of the results.

Figure 10

(i) Predict the acceleration if discs with a total mass of 800 g are used.

(1)

acceleration = ... m/s²

(ii) There are frictional forces in the system.

Identify a feature of the graph that shows there are frictional forces in the system.

(1)

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(iii) Explain how the investigation could be developed to remove the effects of friction.

(2)

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(Total for question = 4 marks)

Q4.

A student investigates the relationship between force and acceleration for a trolley on a runway.

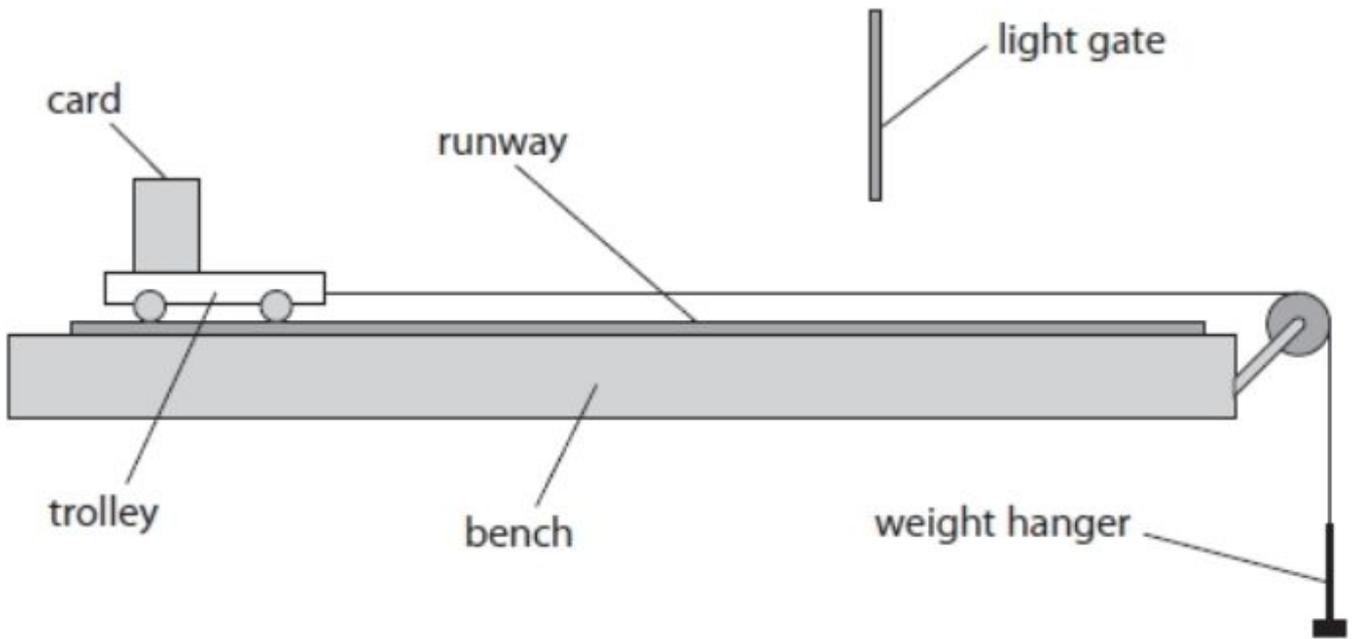Figure 12 shows some of the apparatus the student uses.

Figure 12

(i) Describe how the student could increase the accelerating force applied to the trolley.

(2)

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(ii) Describe how the mass of the moving system can be kept constant.

(2)

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(iii) Explain how the student could improve the procedure to compensate for the effects of frictional forces acting on the trolley.

(2)

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(Total for question = 6 marks)

Q5.

The earthquake causes seismic waves.

(i) S waves are one type of seismic wave. They travel at 0.65 km/s.
There is a seismometer 80 km away from point E.
Show that it takes about 2 minutes for the S waves from the earthquake to reach the seismometer.

(2)

(ii) P waves are another type of seismic wave.
They travel about 10 times more quickly than S waves.

Describe how scientists can use seismometer records of P and S waves to locate the epicentre.

(3)

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(iii) Seismic waves have a frequency of about 15 Hz.
P waves have a much smaller amplitude than S waves.

Some people claim that animals can detect an earthquake before people are aware of it.
Suggest an explanation for this.

(2)

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Q6.

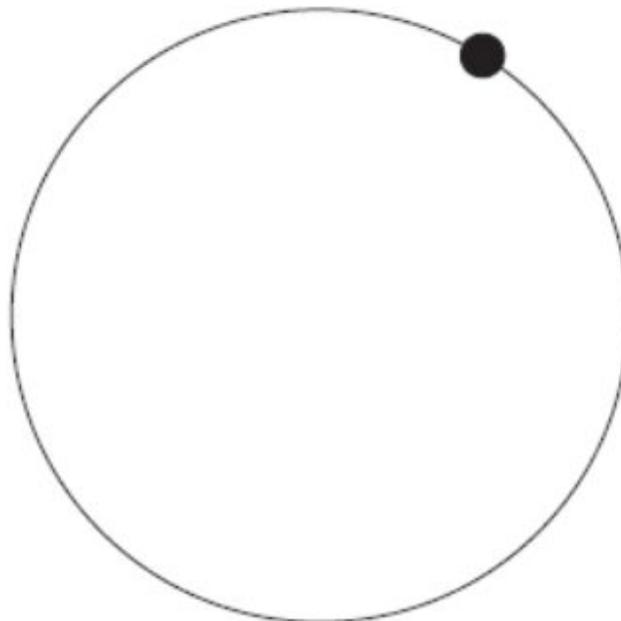Figure 11 shows an object moving in a circular path.

Figure 11

(i) Draw an arrow on Figure 11 to show the direction of the force that keeps the

object moving in a circular path.

(1)

(ii) The object in Figure 11 is moving at constant speed.

Explain why it is not moving with constant velocity.

(2)

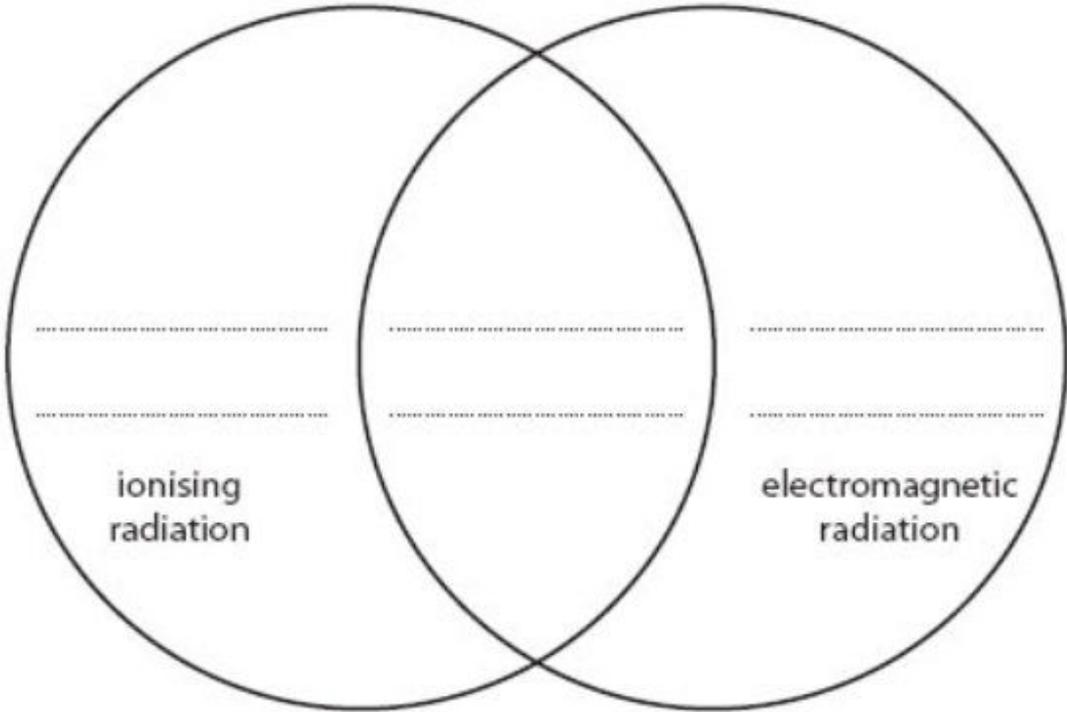..

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Q7.

(a) Skin cancer can be caused by radiation from the Sun.

Complete the sentence by putting a cross (▇) in the box next to your answer.
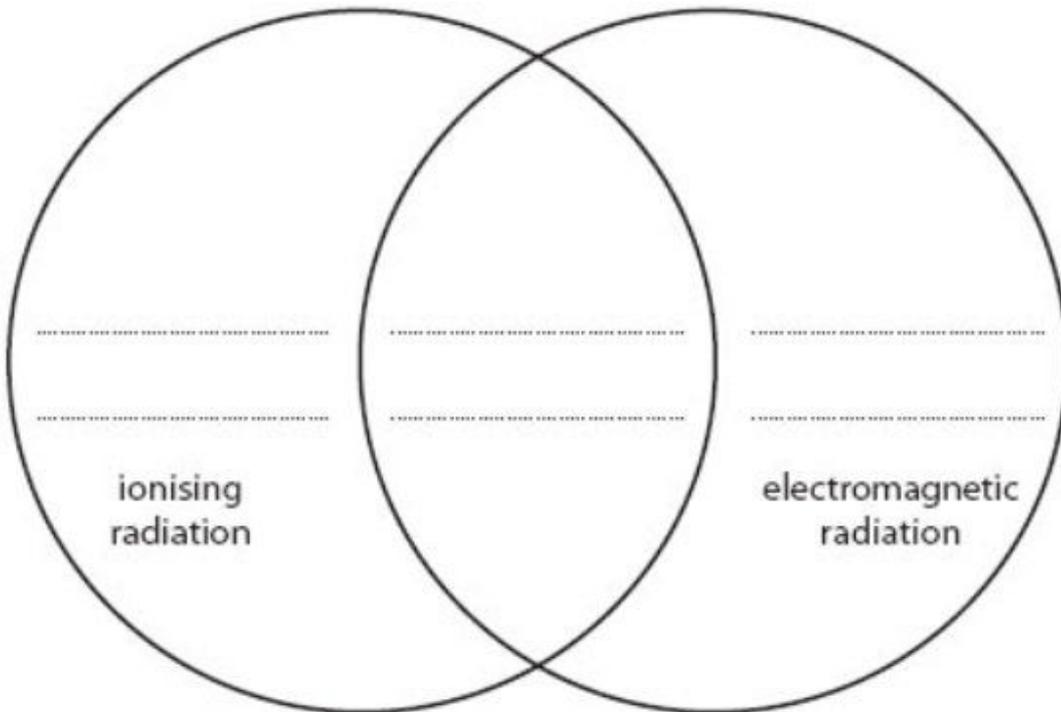
The radiation that causes skin cancer is

(1)

ionising radiation   electromagnetic radiation

A ultraviolet radiation

ionising radiation   electromagnetic radiation

B radio waves
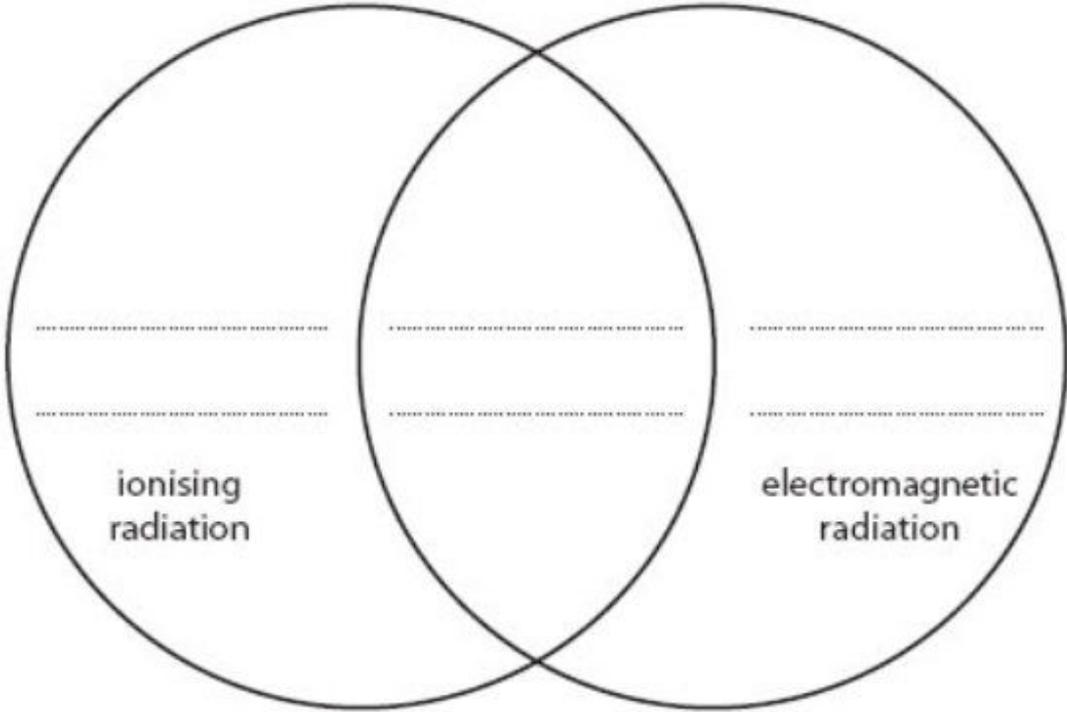
(two Venn diagrams, each with circles labelled "ionising radiation" and "electromagnetic radiation" with dotted lines for answers)
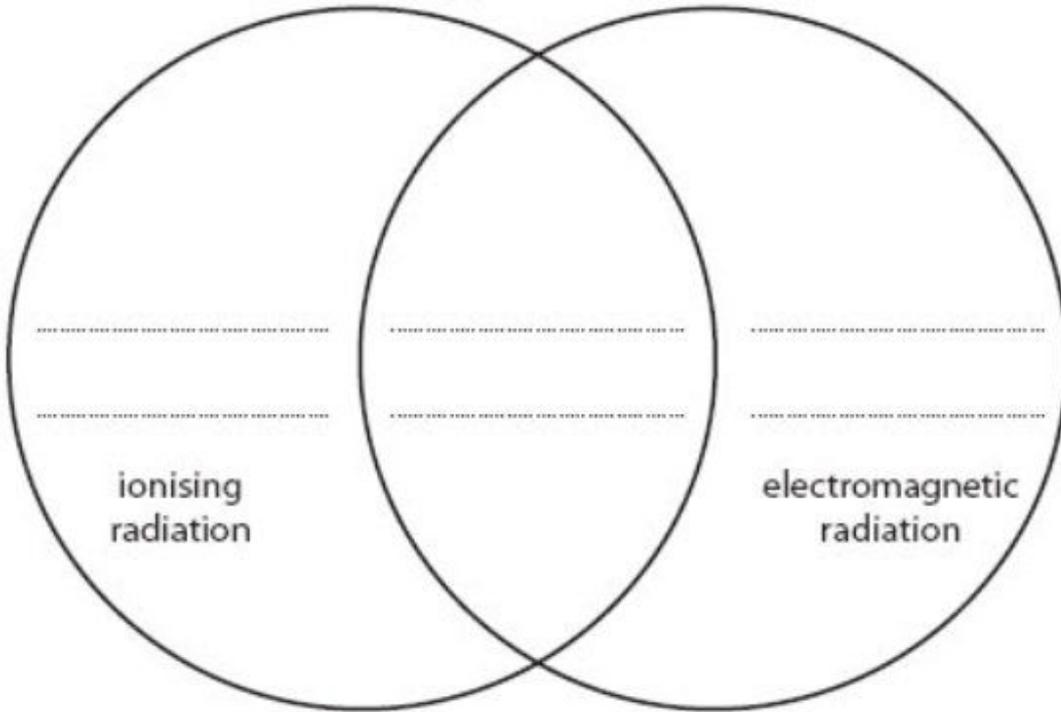
C microwaves

D infrared radiation

(b) The word box contains the names of three types of radiation.

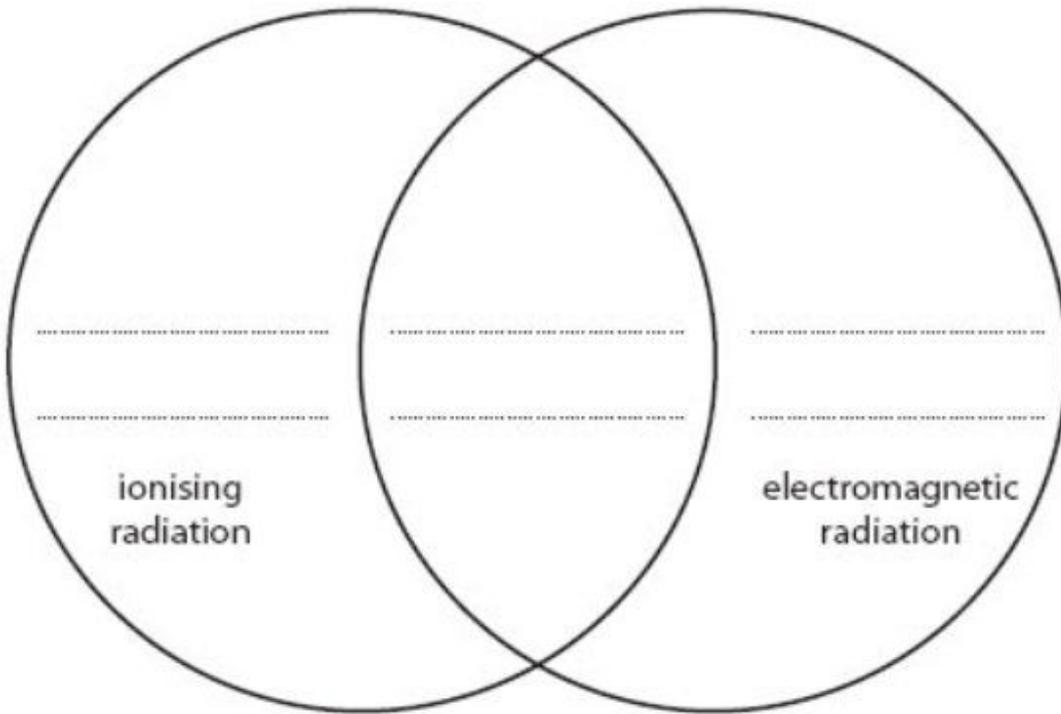| gamma rays   infrared radiation   alpha particles |
|---|

Use this diagram to classify the three types of radiation given in the word box.
Write the name of the radiation in the correct section of the diagram.

(2)

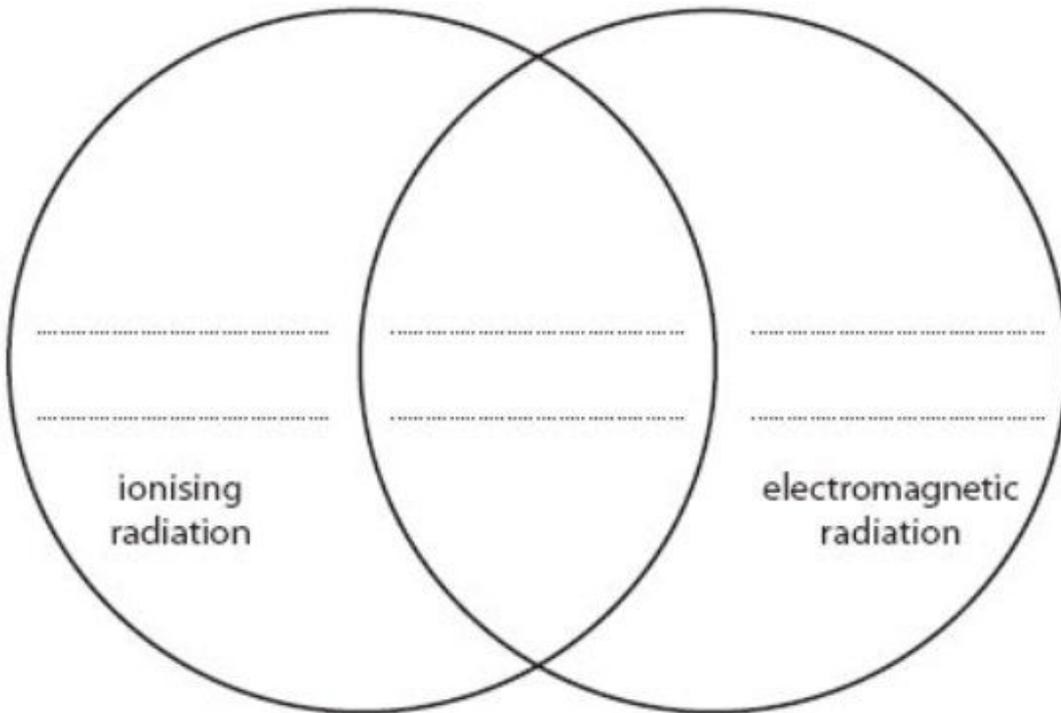(c) Which of these is correct for all electromagnetic waves in a vacuum?

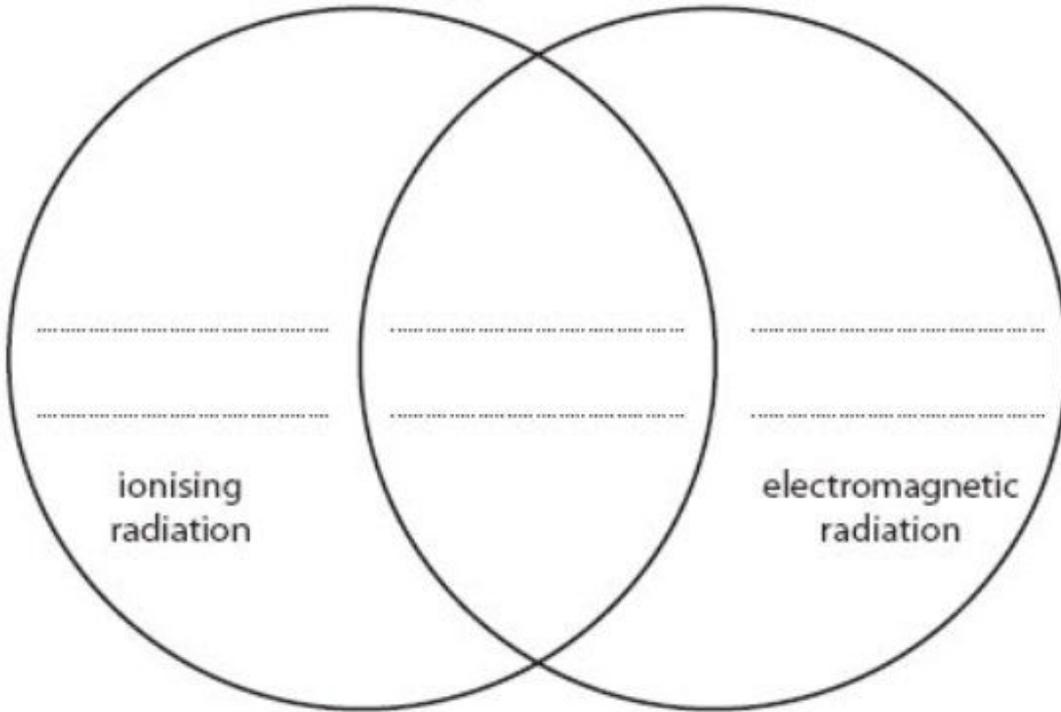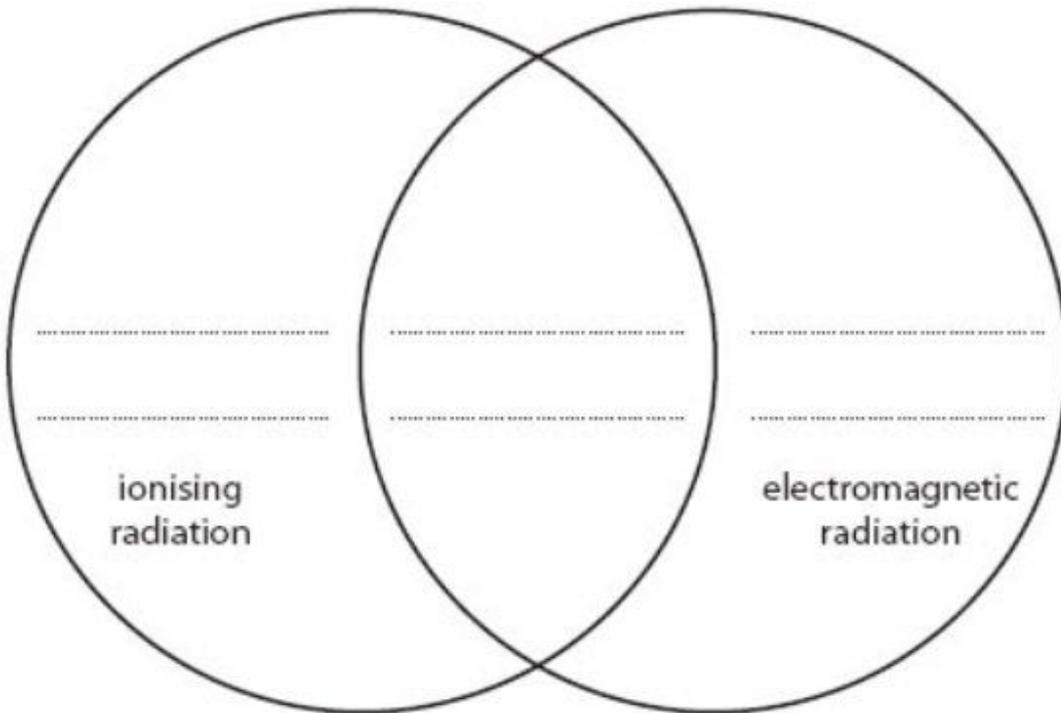Put a cross (▮) in the box next to your answer.

(1)

ionising
radiation

electromagnetic
radiation

A they have the
same frequency

ionising
radiation

electromagnetic
radiation

B they have the
same wavelength

....

....

ionising radiation   electromagnetic radiation

C they are transverse waves

....

....

ionising radiation   electromagnetic radiation

D they are longitudinal waves

(d) Describe a use of gamma radiation.

(2)

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*(e) Herschel and Ritter carried out experiments that contributed to the discovery of infrared and ultraviolet radiation.

Explain how the results of the experiments carried out by Herschel and Ritter led to these discoveries.

(6)

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(Total for Question is 12 marks)

Q8.

The symbol '*g*' can be used to refer to the acceleration due to gravity.

The acceleration due to gravity '*g*' has the unit of m/s^2.

'*g*' can also have another unit.
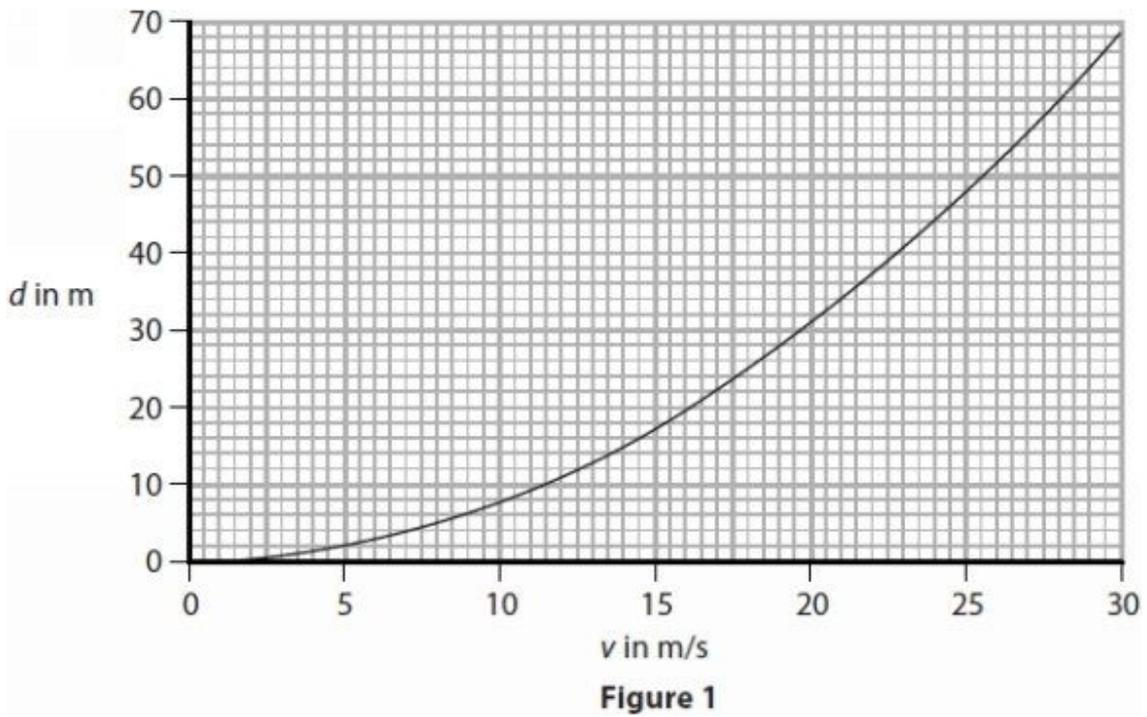
Which of these is also a unit for *g*?

(1)

☒ **A** J/kg

☒ **B** J/kg^2

☒ **C** N/kg

☒ **D** N/kg^2

(Total for question = 1 mark)

Q9.

The graph in Figure 1 shows how the braking distance, *d*, of a car depends on the velocity, *v*, of the car when the brakes are first applied.

Figure 1

An equation relating braking distance, d, to velocity, v, is

$$d = \frac{v^2}{C}$$

where C is a constant.

Use the equation and data from the graph in Figure 1 to calculate a value for C.

Give a unit for C.

(4)

C =.. unit ....

(Total for question = 4 marks)

Mark Scheme

Q1.

Question number	Answer	Additional guidance	Marks
(i)	recall K.E.= ½ m v²(1) rearrangement (1) (m =) 2 x K.E. ÷ v² substitution (1) (m =) 2 x 960 000 ÷ 40² Evaluation (1) = 1200 (kg)	award full marks for the correct answer without working rearrangement and substitution in either order Ignore POT until evaluation	(4)

Question number	Answer	Additional guidance	Marks
(ii)	Use of efficiency equation (1) $\frac{960}{5}$ evaluation (1) =19 (MJ)	award full marks for correct numerical answer without working accept 19.2 (MJ)	(2)

Q2.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	A		(1)

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	A description to include any two of • Gravitational / potential energy reduces (1) • kinetic energy increases (1) • total energy remains constant (1)	Ignore energy changes resulting from impact with sand GPE reduces KE increases Allow GPE is transferred to KE for 2 mark	(2)

Question Number	Answer	Acceptable answers	Mark
(b)	A explanation linking • (work is done) displacing the sand (1) with EITHER • (as) <u>kinetic</u> energy of the ball(s) has been transferred (1) OR • by the force between the ball and the sand (1)	sand moving/ pushing/ blowing upwards OWTTE or ball sinking into sand	(2)

Question Number	Answer	Acceptable answers	Mark
(c)(i)	transposition mass = momentum / velocity (1) substitution mass = 0.46 / 6.2 (1) evaluation 0.074 (kg) / 74g (1)	Subst. and transform. either order 1 mark only can be scored for correct substitution after incorrect transposition. Give full marks for correct answer with no working. Answers that round to 0.074 (kg) 0.07 (kg)	(3)

Question Number	Answer	Acceptable answers	Mark
(c)(ii)	substitution (impact) force = 0.46 / 0.17 (1) evaluation 2.7 (N) (1)	Give full marks for correct answer with no working. Ignore power of ten error until evaluation Answers which round to 2.7 Allow ECF if candidate has used mass from part (i) in F=m(v-u) / T F= $\frac{6.2 - 0}{0.17}$ X 0.074 (1) = 2.7 (N) (1)	(2)

Q3.

Question number	Answer	Additional guidance	Mark
(i)	4.4 m/s ^{2}		(1)

Question number	Answer	Additional guidance	Mark
(ii)	graph (if projected back) does not pass through origin OWTTE (1)	accept not a straight line	(1)

Question number	Answer	Additional guidance	Mark
(iii)	An answer that combines the following points to provide a plan/method: • raise left hand end of runway (1) • (so that) force of gravity on trolley will balance frictional forces (1)	 (so that) trolley travels at constant speed when given a small push	(2)

Q4.

Question Number	Answer	Additional guidance	Mark
(i)	a description to include: add weight / mass (1) to the weight hanger (1)	ignore references to friction here by inclining runway allow (component of) gravity to act on trolley	(2) AO 1 2

Question Number	Answer	Additional guidance	Mark
(ii)	a description to include: transfer mass (1) between trolley and hanger (1)	allow weight(s) for mass mass removed from trolley = mass added to hanger for 2 marks	(2) AO 1 2

Question Number	Answer	Additional guidance	Mark
(iii)	an explanation that links: raise one end of the runway (1) (so that) trolley (not attached to weight hanger) rolls at constant speed / just starts to move / (force of) gravity (on the trolley) balances forces of friction (1)	 credit methods for reducing friction directly (e.g. oil wheels, runway etc.) to reduce (effects of) friction allow credit for identifying magnitude of frictional forces and subtracting or using graph	(2) AO 3 3b

Q5.

	Answer	Acceptable answers	Mark
(i)	substitution (1) 0.65 = 80 / t transposition (1) t = 80 / 0.65 (123 seconds)	transposition and substitution can be in either order . Allow reverse calculations eg speed = 80/120 (1) = 0.67 (about 0.65) (1) or distance = 0.65 × 120 (1) = 78 km (about 80) (1).	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	A description linking any three detection of arrival of P and S waves (1) measurement of difference in arrival times (1) calculation of distance (from epicentre to station) (1) triangulation/using three / several stations (1)	Reward suitable labelled diagram	(3)
(iii)	A suggestion including any two of the following Infrasound (1) some animals can hear waves below human frequency range / 20 Hz (1) they could hear P waves arriving before the (stronger) S waves arrive (1)	Some animals have greater audio / tactile sensitivity than humans	(2)

Q6.

Question Number	Answer	Additional guidance	Mark
(i)	single arrow towards centre of the circle applied to the object (1)	judge by eye	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	an explanation including velocity is a vector (1) (because) direction changes (1)	velocity has (magnitude and) direction / velocity is speed in a (certain) direction	(2)

Q7.

		Answer	Acceptable answers	Mark
	(a)	A		**(1)**
	(b)	alpha particles (In the left section) gamma rays (centre section) infrared radiation (right section) (2)	Any one in correct position for one mark, all three in correct position for two marks	**(2)**
	(c)	C		**(1)**
	(d)	A description to include The purpose of using gamma radiation (1) Some relevant detail about how it achieves the purpose (1)	Purposes may include sterilising food /medical equipment detection / treatment of cancer imaging /detect flaws in materials	**(2)**

		Indicative Content	Mark
QWC	***(e)**	An explanation including some of the following points Results obtained: • Herschel: temperature on thermometer • Ritter: speed of darkening of silver chloride paper Trend of results: • Herschel: hotter towards red end • Ritter: quicker towards blue/violet end Extension of experiment to get more results: • Herschel: measure below red; found it even hotter • Ritter: measure above blue/violet; paper darkened quicker Conclusion: • Herschel: Must be radiation below red (Infra Red) • Ritter: Must be radiation above blue/violet (UV)	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• A limited description of either some results or conclusions from either experiment. For example: They measured temperature across the spectrum and found that temperature changed. They put silver chloride paper in the spectrum and found that it darkened at different speeds with different colours. The answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• A simple explanation of results and conclusions from both experiments . For example: Herschel measured the temperature across the spectrum and found it hotter towards the red end. This was infra red radiation. Ritter measured the darkening of chloride paper across the spectrum. It was quicker towards the violet end. They had discovered ultra violet.	

		• the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 - 6	• a detailed explanation of all the results obtained from both experiments and the conclusions from these results. For example a response as for level 2 given above but with detail about results being obtained from outside the visible spectrum • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q8.

Question Number	Answer	Mark
	C N/kg is the only correct answer	(1) AO 1 1
	A J/kg is not dimensionally the same as m/s²	
	B J/kg² is not dimensionally the same as m/s²	
	D N/kg² is not dimensionally the same as m/s²	

Q9.

Question Number	Answer	Additional guidance	Mark
	use values from graph (1) e.g. $v = 20$, $d = 31$	accepting values to within one square	(4)
	rearrangement (1) $C = \dfrac{v^2}{d}$		
	evaluation (1) $(C=)\ 13$	allow numbers from 12.5 to 13.5	
		award 3 marks for the correct numerical answer without working	
	unit (1) m/s^2	independent mark	