A Guide to A level Physics at Xaverian College

Welcome to Physics at Xaverian College. This guide should answer any questions about what to expect from the course.

Preparation for Year 12

We understand that your transition from school to college will be very unusual this year. Firstly, please feel reassured that we will do our very best to ensure that each of our students is ready to start the A level material once we have worked on a transition unit at the start of the course.

If you want to continue practising your skills, any GCSE questions are a good starting point especially those with calculations.
A selection of optional questions with answers are included at the back of this guide.

You could have a look at the GCSE section of IsaacPhysics.org. This free website has more challenging problem solving and also provides the solutions.

Try to read some scientific stories in the news, in the New Scientist magazine or on the Institute of Physics website. This is a good way to stay motivated and look forward to starting the A level course.

What does your teacher expect from you?

- Full attendance and punctual arrival to lessons
- All equipment every lesson including scientific calculator
- Proactive attitude in class – ask and answer questions in every lesson
- Homework assignments completed and handed in on time
- Use of subject support on a timely basis to respond to feedback
- Notes and worked examples reviewed in advance of next lesson
- Independent study time used to access Kerboodle textbook and question

What should you expect from your teacher?

- Clear notes and worked examples covering the whole of the A level syllabus
- Homework set for each topic
- One piece of graded work each week with feedback
- Resources tailored to the specification such as question booklets
- Worked solutions uploaded onto Onedrive

Subject Support

Each week, you will have the opportunity to access extra help from one of the Physics teachers. You can ask any teacher for help and you do not necessarily need to contact your own teacher.

Students use support for a variety of reasons:

- help with homework before the deadline
- an explanation of a topic already covered in class
- going through a worked example or exam question in detail
- reviewing solutions to extra questions completed before the support session
- going through the feedback from a homework task
- catching up if a lesson has been missed
- checking answers to extension questions accessed on Kerboodle

The timetable for subject support in 2020/21 will be available shortly. Any of the Physics teachers will help you: Mrs Binks, Mrs McMillan and Mr Pass.

Outline of Topics

The A level Physics course is a two year programme of study which is examined at the end of the two year course. The exam board is OCR and the specification is A level Physics A.

There are three exams: Modelling Physics; Exploring Physics and Unified Physics. Here is a list of the topic units included on each of these exams:

Modelling Physics	**Exploring Physics**
Motion	Basic Waves
Projectiles	Refraction
Dynamics	Interference
Statics	Standing Waves
Moments	Polarisation and Diffraction
Work, Energy and Power	Wave Particle Duality
Pressure, Density and Archimedes	Photoelectric Effect
Materials	Fundamental Electricity
Newton's Laws	Series and Parallel Circuits
Life of Stars	Resistance Characteristics
Cosmology	Potential Dividers
Circular Motion	EMF and Internal Resistance
Gravity	Resistivity
Simple Harmonic Motion	Capacitors
Specific Heat Capacity	Electric Fields
Ideal Gas Equation	Magnetic Fields
Kinetic Theory	Electromagnetism
	Nuclear and Particle Physics
	Radioactivity
	Fission and Fusion
	X-rays
	Medical Imaging
Year one topics	
Year two topics	

Unified Physics covers all topics above

Practical Endorsement

Your exam grade depends only on your performance in the three exams at the end of the two year course. The grade is reported with a ‘Pass’ or ‘Fail’ for the practical skills endorsement. You will complete a minimum of twelve practical tasks evidenced in your lab book and your teacher will check that you have acquired the required skills over the two year course.

In addition, you can expect about 15% of the questions in your exams to test your understanding of practical skills. There are two separate topics that deal with this, one at the start of the course and one towards the end of the two year course.

Overview of Exams

OCR
Oxford Cambridge and RSA

Modelling Physics

2hrs 15mins

100 marks (37% of A Level Grade) consisting of 15 multiple choice questions and 85 marks of long questions

Exploring Physics

2hrs 15mins

100 marks (37% of A Level Grade) consisting of 15 multiple choice questions and 85 marks of long questions

Unified Physics

1hr 30mins

70 marks (26% of A Level Grade)

No multiple choice, all long questions across all topics

Expect several topics within one question

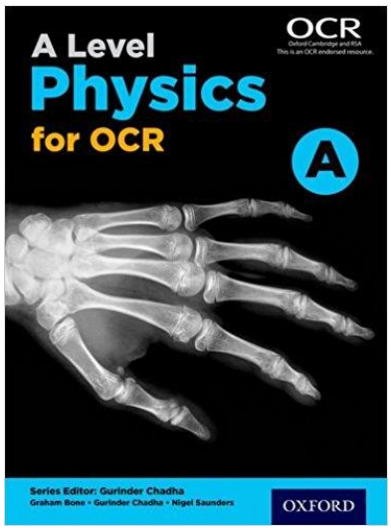
Extracurricular Opportunities

As opportunities arise, your teacher will ask you if you are interested in attending various events, lectures and trips. Examples include:

- British Physics Olympiad papers
- Lectures by specialists in a specific field of Physics
- Work experience at Jodrell Bank and Nuffield Research Placements
- Experience days at universities specifically for Physics or Engineering
- Christie Hospital Medical Physics open evening
- Engineering Careers Day at Siemens plc

Textbook

The textbook for the course is A Level Physics for OCR A



There is an online version of this book at www.kerboodle.com

You will be given a login for this in one of your first lessons. You will also need the institution code which is **as1**.

You are expected to use this book to review work already covered and to complete the summary questions for each topic as part of your independent study. The relevant sections are given at the top of each classwork booklet.

Assessment

You will have 5 formal assessment points across the two year course but you will be assessed on a very regular basis within the Physics department. This will take the form of class tests lasting between 30 minutes and 2 hours.

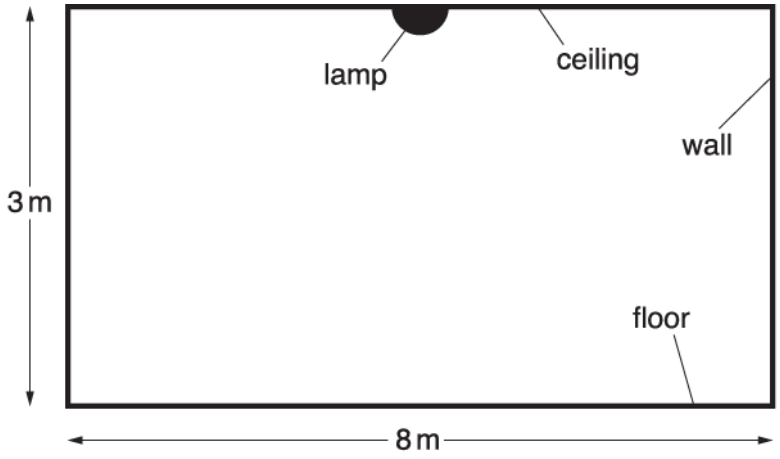
Homework is given weekly and a deadline given by your class teacher. Guidance on additional independent study is also given after each lesson.

At the end of year one you will have an end of year exam, consisting of two papers each 90 minutes in length.

GCSE QUESTIONS

If you want to continue practising your skills, GCSE questions are a good starting point - especially those with calculations.
Feel free to work through the following optional questions if you wish.

1. Michael designs an office with a square floor area of 8 m by 8 m, and a ceiling height of 3 m. He wants to light the office with a single lamp in the centre of the ceiling, as shown below.



side view

To satisfy planning regulations, Michael needs to select a lamp power that will give an intensity of at least 150 lux everywhere in the office. This should include the furthest corners of the room, which are 6.4 m from the lamp. The light intensity in lux from a lamp of power *P* varies with distance in m according to this formula

$$\text{intensity in lux} = \frac{20 \times P}{(\text{distance in m})^2}$$

Suggest why planning regulations require a minimum light intensity, explain why the light intensity varies with distance from the lamp and calculate a suitable power for the lamp.

The quality of written communication will be assessed in your answer..

[6]

2. The table shows typical wavelengths of different parts of the electromagnetic spectrum.

Name of region	Typical wavelength (m)
radio waves	5.0
microwave	0.1
infrared	5.0×10^{-5}
visible light	5.0×10^{-7}
ultraviolet	1.0×10^{-7}
X-rays	1.0×10^{-10}
gamma rays	1.0×10^{-12}

Very short wavelength radiation can be hazardous.

Which **two** of the following statements, put together, can explain this?

Put ticks (✔) in the two correct boxes.

Very short wavelength radiation has very high frequency. ☐

Radiation of wavelength greater than 1 cm can cause cancer. ☐

The energy of a photon is directly proportional to its frequency. ☐

Long wavelength radiation is not absorbed by living organisms. ☐

Very short wavelength radiation is absorbed by the atmosphere. ☐

[2]

3(a). A 230 V mains-powered electric drill draws a current of 2.5 A.

Calculate the power of the drill when it is in use.

power = ... W **[2]**

(b). Another electric drill has a power rating of 600 W. Calculate the number of joules of energy transferred when this drill is in use for 5 minutes.

energy = ... J **[2]**

(c). Calculate the energy transferred by the 600 W drill when used for 5 minutes in kWh.

energy = ... kWh **[2]**

4(a). Roy is stacking shelves at the supermarket.

He lifts boxes of tins from the floor to the shelves.

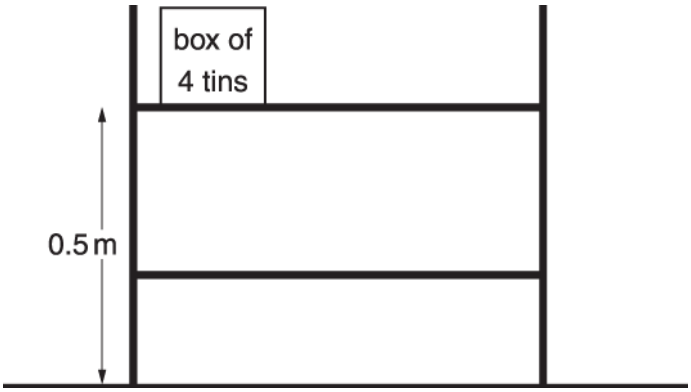
Each tin weighs 5 N.

An empty box weighs 2 N.

i. What is the smallest force that Roy has to pull on a **box of 4 tins** when lifting it?

force = ...N **[1]**

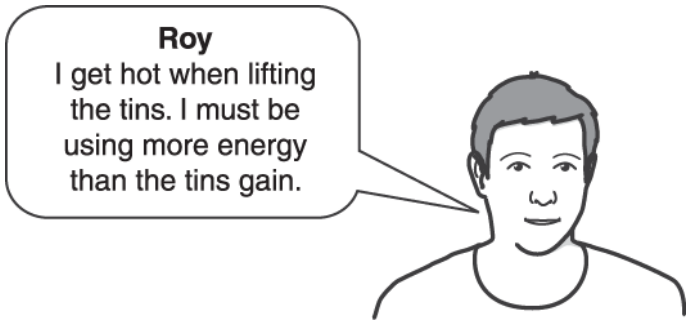
ii. Roy lifts a box of 4 tins from the floor to a shelf 0.5 m above the floor.



Calculate how much gravitational potential energy the box gains.
Include the correct unit in your answer.

gain in gravitational potential energy = ... unit .....
[2]

iii.



State what is meant by **conservation of energy** and explain how it applies to Roy.

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[2]

(b). A box of tins of total mass 3.2 kg, weight 32 N, falls from a shelf.

The shelf is 1.5 m above the ground.

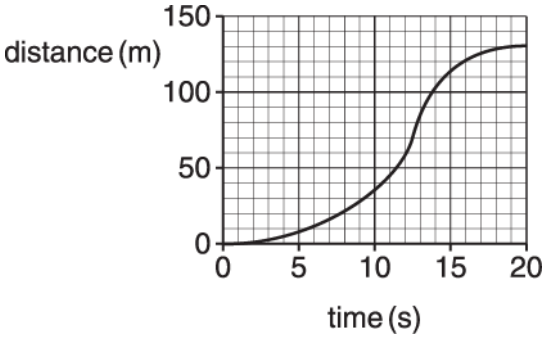
Calculate the speed of the box just before it hits the ground. Show your working.
You may assume that the effect of air resistance is negligible.

speed = ...m/s **[3]**

5(a). Lorries are fitted with tachometers that automatically record their speed and distance travelled.

The data from the tachometer can be used to produce graphs.

Here is the distance-time graph for a journey lasting 20 s.



Use the graph to determine:

i. The time when the lorry has the greatest instantaneous speed.

time = ...s **[1]**

ii. The average speed for this journey.

average speed = ...m/s **[2]**

iii. Here are some descriptions of the motion of the lorry during this 20 s journey.
Put a tick (?) in the box next to the correct description.

Speed increases, then decreases until the lorry becomes stationary. ☐

Speed increases, then decreases until the lorry is moving at constant speed. ☐

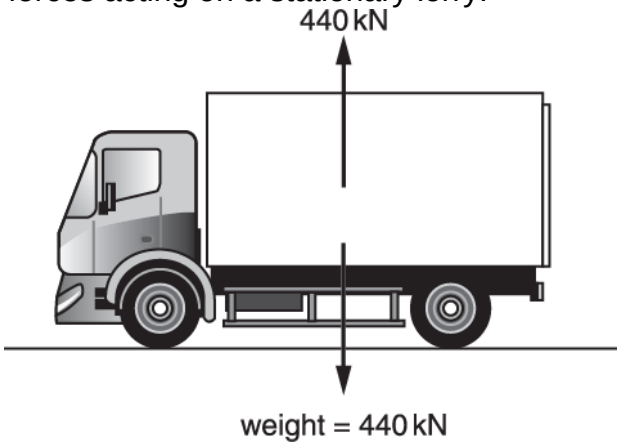
Speed increases until the lorry moves at constant speed. ☐

Speed increases until the lorry becomes stationary. ☐

iv.

v. **[1]**

(b). The diagram shows the forces acting on a stationary lorry.



i. The downward force on the lorry is called weight. What is the name of the upward force?

.....

[1]

ii. The lorry driver says that these two forces must be an interaction pair of forces as they are equal and opposite.

Explain why the driver is wrong.

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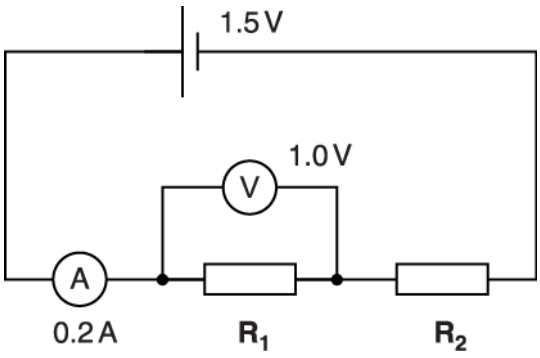
[2]

6(a). Tim also connects resistors in series and parallel.

He sets up this series circuit.



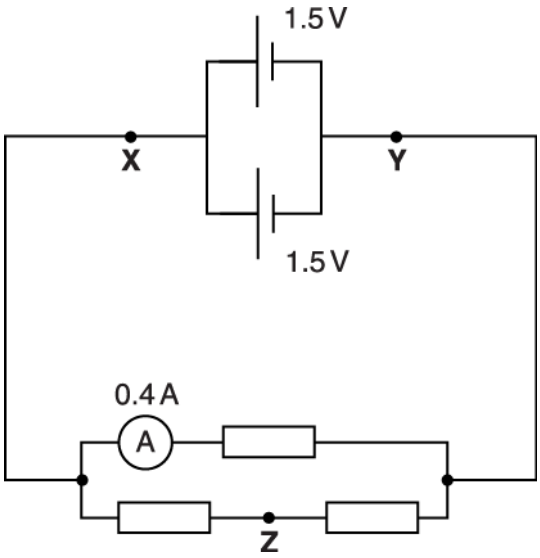
i. Calculate the resistance of R_1.

resistance of R_1= ..... Ω **[1]**

ii. What is the voltage across R_2?

voltage across R_2= ..... V **[1]**

(b). He sets up this parallel circuit.



i. What is the voltage between points **X** and **Y**?

voltage = ... V **[1]**

ii. All the resistors have the same resistance.

What is the current through point **Z**?

current = ... A **[1]**

7. Radioactive sources are used in hospitals.

Radioactive tracers allow the doctor to investigate organs in a patient's body without surgery.

The patient has a radioactive tracer injected into a vein.

The hospital has four radioactive sources, **A**, **B**, **C** and **D**.

Radioactive source	Radiation emitted	Activity (counts per minute)		
		At start	After 1 hour	After 2 hours
A	?	2000	140	8
B	?	1000	490	240
C	?	2000	950	485
D	?	1000	75	5

The doctor wants to use a tracer with a half-life of about 1 hour.

Which radioactive source should the doctor use as the tracer?

Justify your choice using the data in the table.

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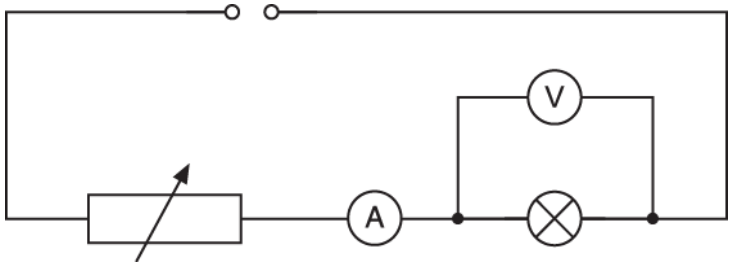
[3]

8. Jason is investigating how the resistance of a filament lamp changes with the current through it.

He connects the lamp to a power supply and a variable resistor.

He uses an ammeter to measure the current through the lamp and a voltmeter to measure the voltage across it.



i. On the diagram put a ring around the symbol for the ammeter.

[1]

ii. These are Jason's results.

Voltage (V)	1.0	3.0
Current (A)	0.10	0.20

iii. How does the resistance of the lamp change as the current increases? Justify your conclusion by doing calculations with Jason's results.

iv.

v. **[3]**

vi. Suggest what Jason can do to ensure his results are accurate.

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[1]

END OF QUESTION paper

Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			**(Level 3)** Explains why illumination must not be too low. Correctly explains the decrease of light intensity with distance. Correctly calculates power of lamp. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **(Level 2)** Two of: explains why illumination must not be too low. Correctly explains the decrease of light intensity with distance. Correctly calculates power of lamp. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **(Level 1)** One of: explains why illumination must not be too low. Correctly explains the decrease of light intensity with distance. Correctly calculates power of lamp. Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **(Level 0)** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to A*** **Indicative scientific points related to official regulations may include:** • low light levels could cause eyestrain • low light levels could result in errors • low light levels could result in accidents to staff • Allow, at L1 only, an interpretation of 'require a minimum' as meaning 'intensity should be as low as possible'. **Indicative scientific points related to variation of intensity with distance may include:** • light spreads out as it travels • area illuminated increases with distance /inverse square law • intensity is power (photons) per unit area • absorption of light by air **Indicative scientific points related to calculation may include:** • rearranges equation • substitutes correct values for intensity (150 lux) and distance (6.4m) • correct answer = 307.2 W = 310 W • accept using 2-D diagram ? d = 5 m & P = 190 W • Allow, at L1 & L2, partial credit in this area for a calculation with one error only; e.g. 48 W (not squaring 6.4 m) or 180 W (using 3mx8m instead of 6.4m^2) **Use the L1, L2, L3 annotations in Assessor; do not use ticks.** **Examiner's Comments** This was the most difficult of the extended-response questions in the paper. Most candidates could explain why the intensity of light falls off with distance, either in terms of photons or in terms of a general wave model, and stronger candidates were able to rearrange the given equation to calculate the required lamp power. A number of candidates read 'suggest why planning regulations require a minimum light intensity' as meaning 'suggest why planning regulations required the light intensity to be

					as small as possible': credit was given for this misinterpretation.
			Total	**6**	
2			boxes 1(short λ ⇒ high *f*) and 3 ($E \propto f$)	2	one mark each **Examiner's Comments** Roughly half of the candidates identified the two correct statements.
			Total	**2**	
3	a		230 V × 2.5 A (1); = 575 (W)(1)	2	575 with no working gets both marks
	b		600 W × (5 × 60 s) (1); = 180 000 (J) (1)	2	3000 J = 1 mark 180 000 / 180 k / 0.18 M with no working gets both marks
	c		0.6 kW × (5/60) h (1); = 0.05 (kWh) (1)	2	Accept for 1 mark answer with just 1 error in conversion W ? kW or min ?h for 1 mark, e.g. 3, 5 or 50 3000 kWh gets no marks accept intermediate rounding 5/60 = 0.083 h ? 0.048 (kWh) 0.05 with no working gets both marks
			Total	**6**	
4	a	i	22 (N)	1	**Examiner's Comments** This question required candidates to use forces and transfer of energy. The majority of candidates scored at least 2 marks, usually in parts (i) and (ii). Only a small minority of candidates scored any marks in parts (iii). The most common wrong answer was 20, due to forgetting to add the weight of the box.
		ii	11 (1); J (1)	2	**allow**: ECF from ai **allow**: j / Nm / joules **do not allow**: n (for N)/ mN **Examiner's Comments** This question required candidates to use forces and transfer of energy. The majority of candidates scored at least 2 marks, usually in parts (i) and (ii). Only a small minority of candidates scored any marks in parts (iii). Error carried forward was applied from part (a)(i) but many candidates failed to see the relationship between

					the two parts. The unit was often wrong or omitted. Most common wrong unit was N, N/m or gpe.
		iii	Total energy stays the same / energy is not lost (or gained) (1);	2	**allow**: energy cannot be created or destroyed **allow**: energy is **only** transferred (into other forms)
		iii	(work done by Roy =) heat (wasted) **and** GPE/energy gained by tins (1)		**ignore** sound / KE of Roy **Examiner's Comments** This question required candidates to use forces and transfer of energy. The majority of candidates scored at least 2 marks, usually in parts (i) and (ii). Only a small minority of candidates scored any marks in parts (iii). The majority of candidates did not know the principle of conservation of energy. Many answers gave the meaning of conservation as retention or saving in reserve. Those candidates that did state the principle were often not able to relate it to Roy's situation. Heat was mentioned as wasted energy but not linked to the GPE of the tins and the total work done by Roy. A number of answers assumed the GPE of the tins became heat.
	b		GPE = KE / Wh = ½ mv^2 (1);	3	**allow**: mgh for Wh **allow**: gh = ½ v^2
			Correct substitution (1);		Correct substitution also gains first marking point. E.g. 32 x 1.5 = 0.5 x 3.2 x v^2 3.2 x 10 x 1.5 = 0.5 x 3.2 x v^2 10 x 1.5 = 0.5 x v^2 48 = 0.5 x 3.2 x v^2 / 48 = 1.6 v^2
			5.5 (1)		5.5 without working gains 3 marks **allow**: an answer with more than 2 s.f. provided that it rounds to 5.5 **Examiner's Comments** Only a small minority of candidates scored any marks in this part. Most candidates did not see that the question was about transferring GPE to KE. Some calculated the GPE as 48 J but did not link it to KE. A few candidates gave well-explained answers showing their working. Some tried using the equations for average speed or momentum.
			Total	**8**	
5	a	i	12.5 (s)	1	**allow** 12-13 **Examiner's Comments** Most candidates scored at least 3 marks for this question

					dealing with forces and motion. A common wrong answer was 20.
		ii	130/20 (1); 6.5 (m/s) (1)	2	6.5 without working gets 2 marks **Examiner's Comments** Those candidates who chose the correct distance of 130 usually calculated the average speed correctly. The most common wrong answer was 7.5 obtained by candidates who read the distance as 150 m.
		iii	Speed increases, then decreases and the lorry becomes stationary – tick in top box	1	**Examiner's Comments** Less than half the candidates chose the correct answer.
	b	i	(normal) reaction	1	**Examiner's Comments** The correct term, reaction, was not known by the majority of candidates. Common wrong answers were upthrust, lift, gravity, air resistance and resultant.
		ii	(Interaction pair act) on different bodies (2); OR these forces are not the same type of force (1); these forces are gravitational and reaction/(normal) contact force (1)	2	**allow** for 1 mark: these forces/they are on same body (OWTTE)
		ii			
		ii			**ignore** references to equal and opposite forces **Examiner's Comments** There were just a very small number of candidates who gave answers showing an understanding of what an interaction pair of forces is, usually by saying that they act on different bodies. A significant number of candidates argued wrongly that an interactive pair are not equal otherwise the lorry would not move.
			Total	**7**	
6	a	i	5 (?)	1	**Examiner's Comments** The rules governing voltages and currents in series and parallel circuits are either not well known or candidates have difficulty applying them. Candidates answered this part the best. Some candidates had difficulty dividing by 0.2.

		ii	0.5 (V)	1	**allow** ½ **Examiner's Comments** Many candidates did not recognise the significance of both voltmeter readings in the question. Common wrong answers were 1.5 V and 1.0 V.
	b	i	1.5 (V)	1	**allow** 1½ **Examiner's Comments** The rules governing voltages and currents in series and parallel circuits are either not well known or candidates have difficulty applying them. Less than half the candidates were able to give the correct voltage. The most common wrong answer was 3.0 V.
		ii	0.2 (A)	1	**allow** ? **Examiner's Comments** Only a few candidates gave the correct answer. The most common wrong answer was 0.4 A.
			Total	**4**	
7			gamma can exit / be detected outside the body / alpha cannot exit body (1); use of data for sources B or C to show their half-life is 1 hour (1) C (1);	3	**not just** gamma is more penetrating eg. 950 is about half of 2000 look at table for indication of calculation outcomes **not just** 'it goes from 2000 to 950 and then to 485' **do not allow** incorrect statements such as 'half-life is 500' **Examiner's Comments** Half the candidates scored at least one mark for this question. Many candidates did not show an understanding of how an injected tracer works and failed to read the information in the question carefully enough. Some ignored the statement that the source needed to have a half-life of one hour and instead looked for the one with least activity, to prevent causing cancer, or most activity, to get a good reading. Many thought that alpha is less damaging to humans than gamma and few appreciated that it needed to be gamma in order to exit the body. Many failed to get a mark for correct ideas about the meaning of half-life as they did not follow the instructions in the question to justify their answer using the data in the table. The terms half-life and activity were often interchanged such as in the incorrect statement 'the half-life of C is 500'.

			Total	**3**	
8		i	ammeter symbol ringed	1	**Examiner's Comments** The vast majority of candidates were correct when circling the ammeter symbol in the circuit. A significant minority did not answer this question and candidates should be reminded to read the instructions carefully.
		ii	use of equation R = V/I (1); two values of R calculated (1); resistance increases (as current increases) (1)	3	10 and 15 gains the first two marks **Examiner's Comments** Candidates fared well on this mathematical question. It was pleasing to see the large numbers of candidates carrying out the correct calculations and then using these to describe the correlation.
		iii	repeat readings / more data	1	**Examiner's Comments** Almost all the candidates could suggest that repeating the results was a way to improve the experiment.
			Total	**5**	