OCR
RECOGNISING ACHIEVEMENT

# SPECIMEN H

**GENERAL CERTIFICATE OF SECONDARY EDUCATION**

**GATEWAY SCIENCE**

**PHYSICS B**

**B751/02**

Unit B751: Physics modules P1, P2, P3 (Higher Tier)

**MARK SCHEME**

**Duration**: 1 hours 15 minutes

**MAXIMUM MARK 75**

**This document consists of 20 pages**

## Guidance for Examiners

Additional guidance within any mark scheme takes precedence over the following guidance.

1. Mark strictly to the mark scheme.

2. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise.

3. Accept any clear, unambiguous response which is correct, eg mis-spellings if phonetically correct (but check additional guidance).

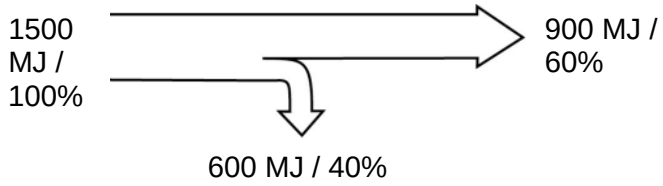
4. Abbreviations, annotations and conventions used in the detailed mark scheme:

   / = alternative and acceptable answers for the same marking point
   (1) = separates marking points
   **not/reject** = answers which are not worthy of credit
   **ignore** = statements which are irrelevant - applies to neutral answers
   **allow/accept** = answers that can be accepted
   (words) = words which are not essential to gain credit
   words = underlined words must be present in answer to score a mark
   ecf = error carried forward
   AW/owtte = alternative wording
   ora = or reverse argument

   eg mark scheme shows ‘work done in lifting/(change in) gravitational potential energy’ (1)
   work done = 0 marks
   work done lifting = 1 mark
   change in potential energy = 0 marks
   gravitational potential energy = 1 mark

5. If a candidate alters his/her response, examiners should accept the alteration.

6. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 1 | (a) | | correct energy values on diagram<br>  <br><br>(2)<br>energy input,<br>(useful) output/heating living room<br>and wasted energy labels correctly positioned / AW (1) | 3 | Sankey diagram drawn with all correct energy values / percentages (2)<br>OR<br>**allow** correctly positioned 600 MJ (1)<br>**allow** correctly positioned 900 MJ (1) |
| | **(b)** | | concept (no mark)<br><br>because concept is the only model where payback time is less than 10 years and this means that Asif saves the most money (£100) over 10 years with the concept (2)<br><br>**OR**<br><br>because concept is the only model where payback time is less than 10 years /<br>over 10 years Asif saves the most money with the concept (1) | 2 | concept not chosen or incorrect model chosen answer scores (0)<br><br>**allow** correct use of figures eg paid £600 and get £700 back in savings at end of 10 years (1)<br><br>**allow** although aspect is more efficient / saves more on fuel each year, aspect costs more than the Concept (1) |
| | | | **Total** | **5** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 2 | (a) | | 226 kJ (2)<br><br>**BUT**<br>0.1 x 2260 (1) | 2 | **allow** 226 000 J (2) |
| | (b) | | because the average kinetic energy of the particles does not change as energy supplied is used to break intermolecular bonds (2)<br><br>**OR**<br><br>average kinetic energy of the particles does not change /<br>energy used to break intermolecular bonds (1) | 2 | **answers must link breaking intermolecular bonds with kinetic energy of particles to gain full credit**<br>**allow** 'water molecules' instead of 'particles'<br><br>**allow** answers in terms of 'overcome forces of attraction between molecules' instead of breaking intermolecular bonds |
| | | | **Total** | **4** | |

| Question | Expected answers | Marks | Additional guidance |
|---|---|---|---|
| 3 | **Level 3**<br>A detailed description of the three processes by which energy is transferred from inside to outside and how energy losses are reduced using cavity wall insulation. Applies knowledge of how inclusion of shiny foil reduces energy loss in the context of a cavity wall. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks)<br><br>**Level 2**<br>Limited description of some processes by which energy is transferred, order from inside to outside may be confused, some reductions by cavity walls described but not linked to different forms of transfer. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks)<br><br>**Level 1**<br>An incomplete description, naming some processes by which energy is transferred. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks)<br><br>**Level 0**<br>Insufficient or irrelevant science. Answer not worthy of credit. (0 marks) | 6 | **relevant points include:**<br><br>• cavity wall insulation slows down the process of heat transfer<br>• cavity wall insulation retains more heat inside the home<br><br>• energy moves by **conduction** through the internal blocks<br>• foam or air is a poor **conductor** / foam or air is a good **insulator** so energy transfer is reduced<br>• air/bubbles trapped (in foam) reduces **convection**<br>• reduces heat or energy **radiated** into cavity<br>• inner silver foil surface reflects heat or IR back<br>• outer silver foil surface emits less heat<br>• energy moves by conduction through the external bricks<br><br>**accept** cavity wall insulation reduces energy losses mainly by conduction and convection<br><br>**ignore** heat escapes<br><br>**reject** heat particles |
| | **Total** | **6** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 4 | (a) | | (**A**) infrared and (**B**) radio waves (1) | 1 | **both correct for one mark** |
| | (b) | (i) | 0.09(m) (2)<br>**but if answer is incorrect**<br>$\frac{3.00 \times 10^{8}}{3.44 \times 10^{9}}$ (1) | 2 | **allow** 0.087(m) (1)<br>**allow** 8.72 cm if unit is clear (2)<br>**but** 8.72 on its own scores 0 |
| | | (ii) | in the range $1 \times 10^{-23}$ to $3 \times 10^{-24}$ (J) (1) | 1 | **ignore** lower level answers below target level for this question eg in the radio range / $< 3 \times 10^{-24}$ |
| | (c) | | **risks**<br>**any one from:**<br>cell damage to brain from heating effects of microwaves (1)<br>which could lead to <u>possible</u> increased risk of brain tumours (1)<br><br>**ways of limiting risks**<br>risks can be reduced by using speakerphone or headset /<br>reduce risk by using for only short conversations (1)<br><br>risks may be offset against benefits of using mobile phones (1) | 3 | **to gain full credit candidates must identify a risk, consider possible ways to limit the risks, and weigh the residual risk against the benefits**<br><br>**ignore** more likely to become a victim of crime<br><br>**allow** view that there is not enough evidence to support risks |
| | | | **Total** | **7** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 5 | | | CFCs have depleted the ozone layer / CFCs caused a hole in the ozone layer (over Antarctica) (1)<br>this depletion of the ozone layer allows more ultraviolet radiation to reach Earth /<br>ozone needed to protect Earth from ultraviolet so if there is a hole Earth will not be protected (1)<br><br>idea of needs to be an international ban to have an effect because all countries must stop / it is a worldwide problem that cannot be solved by individual countries (1) | 3 | **answers must link depletion of the ozone layer to more ultraviolet reaching Earth to gain second marking point**<br><br>**allow** idea that even though no new CFCs have been produced (since 1985 in developed nations) previously produced CFC are persistent and remain in the environment for a long time (1) |
| | | | **Total** | **3** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 6 | (a) | | steam turns turbine (1)<br>turbine causes coil to rotate in a magnetic field (1)<br>rotation induces (alternating) current in the coil (1) | 3 | **answers must be in correct order to gain full marks** |
| | (b) | | 600 000 J (2)<br><br>**but if final answer incorrect**<br>addition of output and losses<br>**or**<br>1 000 000 (J) - 400 000 (J) (1)<br>**or**<br>350 000 (J) (useful output) + 50 000 (1) | 2 | **allow** 600 kJ if unit is clear (2) |
| | (c) | | no (no mark)<br><br>because the hydroelectric bar is not 3 times as long as nuclear (1)<br>no scale to show efficiency / not clear if bars are relative lengths (1) | 2 | **allow** approximate calculations of efficiency for hydroelectric power stations assuming bars are proportional eg if nuclear is 33% efficient then hydroelectric is about 70% efficient (1) |
| | | | **Total** | **7** | |

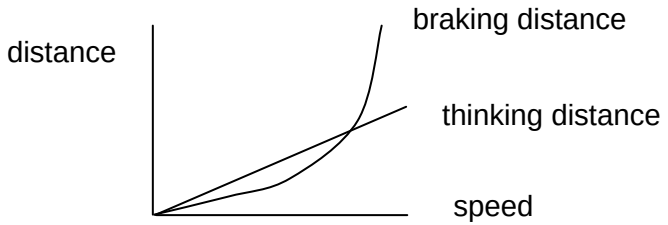
| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 7 | (a) | | previous models had been regarded as correct for a very **long time** /<br>(the Copernican model) went against the (religious) beliefs of the time so it was opposed by **many** people (1)<br><br>it required technological development /<br>development of telescope to provide evidence/test (1) | 2 | **allow** idea that other scientists did not confirm the Copernican model until much later (1)<br><br>**allow** idea that it took a long time for the model to spread because of slow communication and printing (1) |
| | **(b)** | | it was relatively small / faint / did not shine very brightly (1)<br>need a (large diameter) telescope to see it / not possible to view with the naked eye (1)<br>idea of not possible to look at all the sky at once / limited resources (1) | 2 | **allow** because it was coming towards the Earth (on a collision course) it did not change position (1) |
| | | | **Total** | **4** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 8 | | | **Level 3**<br>A clear and detailed description of how a photocell produces electricity including how the electrons are knocked loose from the silicon atoms **and** applies knowledge of factors that affect how output can be maximised to describe in detail methods relating to light intensity and surface area. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks)<br><br>**Level 2**<br>Answer clearly describes how photocells produce electricity but may lack fine detail, for example only 'electrons come from the silicon'. Application of knowledge of factors that affect how output can be maximised may lack detail, for example just 'increase light intensity', OR may be limited to light intensity or surface area. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks)<br><br>**Level 1**<br>Answer attempts to describe how photocells produce electricity but details are not included. Applies knowledge of factors that affect how output can be maximised to suggest one method which is not fully explained. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks)<br><br>**Level 0**<br>Insufficient or irrelevant science. Answer not worthy of credit. (0 marks) | 6 | **relevant points include:**<br><br>**photocell produces electricity by**<br>• photons/energy absorbed by photocell<br>• photocells made up of silicon<br>• electrons are knocked loose from the silicon atoms in the crystal<br>• electrons flow freely<br>• flow of electrons produced is direct current.<br><br>**output can be maximised by**<br>• **increased** surface area exposed by removing anything/trees that could block the Sun<br>• **increased** surface area exposed by increasing the size of the photocell.<br>• site away from trees for maximum light intensity<br>• clean regularly to ensure maximum light intensity<br><br>**allow**<br>• **more flexibility than conventional methods as photocells can be located adjacent to lights**<br><br>**accept** higher level answers describing flow of electrons between n-type silicon and p-type silicon in a p-n junction |
| | | | **Total** | **6** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 9 | (a) | | 0.805 (kilowatts) (2)<br><br>**but if answer incorrect**<br>230 x 3.5 / 1000 (1) | 2 | **allow** 0.8/0.81 (kilowatts) (1)<br>**allow** answer in the table or on the answer line |
| | (b) | (i) | **appliance that costs the most to run**<br>washing machine (no mark)<br><br>**because**<br>**any one from**<br>0.5 x 8 = 4 (kilowatt hours) which is the highest value (1)<br><br>cost depends on power rating and time switched on and the washing machine is on for a long time with (quite a) high power (1) | 1 | **allow** formula cost = time x power (x cost per kilowatt hour) (1) |
| | | (ii) | power rating of satellite dish is very low / total cost of satellite is currently only 1.68 kilowatt hours so will not be much of a reduction (1) | 1 | |
| | | | **Total** | **4** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 10 | (a) | | alpha would not be able to penetrate the skin<br>and so would not reach a detector outside the body (2)<br><br>**OR**<br><br>alpha would not be able to penetrate the skin /<br>alpha would not reach the detector (1) | 2 | answers must link penetration of alpha to reaching detector outside the body to gain 2 marks |
| | (b) | | low level waste can be put in land-fill sites (1)<br><br>waste can be encased in glass and left underground (1)<br><br>waste can be reprocessed to be less harmful (1) | 2 | <br><br><br><br>**not** recycled<br><br>**allow** no (completely) safe way found yet (1) |
| | | | **Total** | **4** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 11 | (a) | (i) | correct axes / time on x axis **and** distance on y axis (1)<br><br>all points plotted correctly (1) | 2 | **allow** +/- ½ square tolerance<br>if points only plotted correctly (with no line), award the mark |
| | | (ii) | 5 (m/s) (1) | 1 | no ecf |
| | | (iii) | straight line with steeper gradient (1) | 1 | must be clear this is the (labelled) faster speed graph<br>if no line drawn **allow** a description of steeper<br>line does not have to start at 4 seconds |
| | (b) | | 52.6 (s) (1)<br>has not beaten his PB (1) | 2 | **allow** 53 (s) or 52.63 (s) (1)<br>**allow** comparison of PB speed with race speed (1) |
| | | | **Total** | **6** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 12 | (a) | | 6 (m/s) (1) | 1 | |
| | (b) | | 1.5 $m/s^2$ (1) | 1 | |
| | (c) | | thinking distance increases linearly so will treble (1)<br><br>braking distance increases as a squared relationship so will be 9 times greater (1) | 2 | **allow** thinking distance is (10 x 3 =) 30m<br><br>**allow** braking distance is (25 x 9 =) 225m<br><br>**allow** graph **but** axes and lines must be clearly shown eg<br><br>  <br><br><br>**allow** lines correct but no labels on axes **allow** (1)<br>**allow** thinking distance line with gradient > braking distance curve gradient (1) |
| | | | **Total** | **4** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| 13 | (a) | | more mass (1) requires greater kinetic energy for a fixed speed, so more fuel needed to supply energy / ora (1)<br><br>**OR**<br><br>streamlining (1) leads to less energy wasted against drag, so less fuel needed to overcome energy wasted / ora (1) | 2 | **factor identified must be linked to change in energy requirement and resultant effect on fuel consumption to gain full credit** |
| | (b) | | Ronan has got fuel consumption back to front – more km per litre is better / AW (1)<br><br>**no mark for choice of car, marks are for valid reasons**<br>most economical / lowest economic impact is vehicle **V**<br>OR best fuel consumption/lowest cost for fuel is car **V** (1)<br><br>environmental impact is a choice between **Z** quietest and **V** lowest $CO_2$ emissions (1) | 3 | **allow** idea that car **Z** will go the shortest distance on a set amount of fuel (1)<br><br>**answers must support choice of car to gain credit** |
| | (c) | | idea that petrol and diesel are finite sources of energy (1)<br>**any one from:**<br>instead we could use more **bio-fuelled** vehicles as they do not use fossil fuels but a renewable fuel (1)<br>instead we could use more **solar powered** vehicles as they do not use fossil fuels but a renewable energy source (1) | 2 | **marking points in either order can gain full credit, answers must include the need to replace petrol/diesel and how this may be done to gain full credit**<br><br>**ignore** references to just 'electric cars' unless source of electricity explicitly does not involve use of fossil fuels. |
| | | | **Total** | **7** | |

| Question | Expected answers | Marks | Additional guidance |
|---|---|---|---|
| 14 | **Level 3**<br>Describes a broad range of ways in which test data could be gathered. Applies understanding of scientific approaches to describe in detail how data could be evaluated and applies understanding of forces and energy to describe relevant factors which produce a safer design. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks)<br><br>**Level 2**<br>Describes a range of ways in which test data could be gathered. Applies understanding of scientific approaches to describe in limited detail how data could be evaluated and applies understanding of energy or forces to describe some factors which produce a safer design. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks)<br><br>**Level 1**<br>Describes a limited range of ways in which test data could be gathered and applies understanding of scientific approaches to suggest a method of evaluation. Some appreciation that reducing injury is an important factor. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks)<br><br>**Level 0**<br>Insufficient or irrelevant science. Answer not worthy of credit. (0 marks) | 6 | **relevant points include:**<br><br>**test data gathered**<br>• use of crash test dummies<br>• use of slow motion films<br>• use of sensors on the dummies<br>• use of different size crash test dummies<br>• tests carried out with and without seatbelts on<br>• tests carried out with and without crumple zones<br>• tests carried out in different cars<br>• tests carried out at different speeds<br>• tests repeated several times/means taken from the data<br>• use of calibration<br><br>**evaluation of data**<br>• use of appropriate format to present the data<br>• use of statistics<br>• use of data from different sources<br>• comparisons with real road accident data<br><br>**factors for safer designs**<br>• to reduce injury<br>• to absorb more energy<br>• to reduce forces on the body<br>• to increase stopping or collision time<br>• to decrease acceleration<br><br>**allow** named examples of different crash test dummies eg SID (side impact dummy) bioRID (rear impact) CRABI (child) and THOR (dummy with greatest range of sensors especially around the face) |
| | **Total** | **6** | |

| Question | | | Expected answers | Marks | Additional guidance |
|---|---|---|---|---|---|
| **15** | | | idea that initially speed changes because weight > drag or air resistance (1)<br><br>idea that she reaches a terminal velocity because weight = drag or air resistance (1) | 2 | **answers must link speed to difference in forces to gain each marking point**<br>**allow** gravity for weight<br>**allow** friction for air resistance |
| | | | **Total** | **2** | |