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1998 HIGHER SCHOOL CERTIFICATE EXAMINATION REPORT

PHYSICS

In 1998, 9311 candidates presented for the 2 Unit Physics examination at the Higher School Certificate Examination.

General Comments

The number of non-attempts and the standard of answers indicated that candidates were not able to apply their knowledge and understanding of Physics concepts so as to score marks.

The following weaknesses were noted:

- candidates had difficulty in clearly expressing explanations and descriptions
- many failed to bring a protractor into the examination and lacked experience in drawing vector diagrams to scale
- while the majority were able to draw graphs satisfactorily, they had problems in relating the relationship shown in the graph to an equation involving the variables in the graph
- a number of candidates were still confused in their use of units, while unit prefixes were often ignored or wrongly converted
- the algebraic skills of many candidates were poor and changing the subject of equations often led to errors. Students should be advised to substitute for all quantities before manipulating an equation.

SECTION I – CORE

PART A

The following table gives the percentage of the candidature selecting each alternative for the multiple-choice answers. *The correct answer is marked with an asterisk.*

Question	A	B	C	D
1	8.35	72.13*	8.36	10.97
2	7.46	13.08	76.08*	3.22
3	4.22	7.49	8.92	79.09*
4	13.00	17.74	38.45*	30.57
5	44.90	42.47*	6.38	6.06
6	3.41	41.74	17.49	37.19*
7	3.67	40.64	19.63	35.76*
8	12.06	6.45	73.96*	7.26
9	62.40*	12.42	11.83	13.13
10	43.90*	33.29	7.64	14.79
11	14.40	30.34*	41.03	13.84
12	30.89	31.81	17.46	19.40*
13	7.80	16.56	60.77*	14.44
14	42.21*	33.22	18.11	5.87
15	74.32*	7.07	3.99	14.25

PART B

Question 16

The question, which involves a canoeist wishing to cross a river to reach a point due north, tests an understanding of both vector addition and relative velocity. Most students were able to draw a vector diagram. Few, however, interpreted the direction correctly. Many converted their answer to $m.s^{-1}$ although the question did not require them to do so and most expressed direction conventionally, whereas an unambiguous bearing would have been preferable.

(a) Students had difficulty in visualising a vector 13 km/h up the stream and hence had difficulty in finding the angle.

(b) A significant number of candidates were unable to represent the triangle of vectors correctly.

(c) Answers to this question indicated that relative velocity is a little understood concept. A significant number of students experienced difficulties in relating this part of the question to (a) and (b), the majority treating part (c) as a separate question.

Question 17

This question examined students' understanding of forces in equilibrium. While some experienced difficulty in interpreting the statement relating 'drag', 'lift' and 'weight', the majority were able to complete a scale diagram, but some failed to use labels and arrows to show directions. The majority of students could determine the scale of a diagram and find a value for the tension by either scale or calculation. Some failed to substitute values to produce a numerical value for tension, while the scale of 1 cm = 1.92 newtons caused problems for a number of students, particularly with rounding off numbers.

Question 18

This question focused on students' understanding of the general principles of momentum and the relationship between forces in collisions. It was generally well answered, with candidates indicating a basic understanding of conservation of momentum, although this was often poorly expressed.

(a) Students experienced most difficulty with this part. Many students failed to reason from the forces as to why the momentum was conserved.

(b) This part was well answered, with most candidates realising that conservation of momentum applied only to the total momentum of the system.

(c) Many students struggled to provide a clear explanation of why the momentum of A was not conserved.

Question 19

This question focused on students' understanding of momentum in two dimensions. It was poorly answered, with most responses showing a lack of understanding of momentum in two dimensions. Many students failed to make a genuine attempt at answering the question and many of those who did tried to solve the problem linearly.

Students experienced difficulty in extracting information from an unfamiliar graph and those who did extract the information correctly were often not able to apply it correctly.

Question 20

This question required students to use Ohm's and Kirchoff's Laws to find the current through a parallel resistor and then to use their understanding of power and energy to calculate the energy dissipated in the resistor over a period of time.

(a) Students approached this question in several different ways, most commonly using a ration method and correctly applying Ohm's Law. The most common error was confusing the number 12 in the calculation of the parallel resistance with the 12V total potential difference or failing to convert time to seconds.

(b) Most students showed ability to calculate the parallel voltage using Kirchoff's Law. A small number of students used 12V as the voltage across the 5 Ohm resistor.

(c) While just over half of students answered this question using $E = VIt$, I^2Rt or V^2t/R, many failed to convert time to seconds and some confused power and energy.

Question 21

This question required students to use stimulus on the ampere-hour battery to calculate the amount of charge and energy stored in the battery. They were then required to refer to their understanding of energy principles to explain why the transfer of energy to the motor was not 100% efficient.

Some students did not attempt this question or were confused by the terms 'capacity' and 'ampere-hours' and/or the concept of a 40-ampere-hour battery.

(a) (i) A small number of students calculated the number of electrons in response to this question; most did not apply $q = It$.

(ii) Students should have applied $E = Vq$ and, if they did not remember this equation, they were disadvantaged.

(b) Many students were unfamiliar with the term 'mechanical work', and their answers were related to the car rather than the specified electric motor. These students provided answers such as 'energy is lost in the lights', 'the battery is flat and should be recharged', 'the car continually recharges so it does not run out of energy'. Some students did not recognise this as an energy conversion question; many recognised the effect of internal resistance.

Question 22

This question required students to explain the need for a split-ring commutator and for brushes in a simple DC motor. They were also required to calculate the maximum torque on a current carrying coil in a magnetic field.

(a) (i) While students generally indicated an understanding of the role of the split-ring commutator, many had difficulty in expressing themselves clearly; some attempted to describe what would happen without a split-ring commutator.

(ii) The need for brushes in a simple DC motor was not as well understood as the need for the split-ring commutator. Some students stated that the brushes kept the commutator clean, while a smaller but significant number thought that the function of the brushes was electrostatic.

(c) The calculation of the maximum torque was generally well handled. Some candidates interpreted the total area of the 300 turns of the coil as being 1.2×10^{-3} m^2 and incurred no penalty. Very few expressed the correct units for the torque.

Question 23

This question required students to sketch the magnetic field about two parallel current-carrying conductors, to indicate the direction of the force on one wire due to the current in it and to calculate the magnetic flux density at a point midway between the wires.

(a) This part was poorly done by most students. The drawing was generally of poor quality, with very few responses showing how the magnitude of the field varied. Most candidates represented the field by concentric circles around each conductor; a number, however, allowed field lines to touch or even cross.

(b) Students found many ways to show the direction of the force on wire A. Some responses were unclear, ambiguous or contradictory. Students frequently simply wrote ‘repelled’.

(c) The term ‘magnetic flux’ density was not well understood, with many students using Ampere’s Law to calculate the magnitude of the force between the two conductors. Many failed to realise that a vector addition was required or simply assumed that the fields cancelled. Some students successfully calculated the magnetic flux density at a point 0.6 units from one of the wires, rather than at the point P midway between the wires.

Question 24

(a) Superposition of two waves was clearly demonstrated by most students.

(b) The better students were able to move the wave and correctly draw the resultant showing constructive interference. A significant number of students who did not score full marks were still able to show some understanding of superposition.

Question 25

The influence of the solid and liquid media on the propagation of waves was not clearly conveyed by most students. A significant number of students were penalised for making contradictory statements in their justification.

Question 26

Most candidates were able to recognise the two dimensional approach that was required to solve projectile motion problems.

(a) This question was correctly answered by about half the candidates. Some failed to answer the question in terms of the symbols, even though they could correctly answer part (b). Many were unable to calculate components or wrongly applied trigonometric functions. A number incorrectly wrote equations in terms of horizontal and vertical components.

(b) Only a quarter of the candidates correctly answered this question in terms of the equations derived in part (a). Many incorrectly assumed that the tree was the middle of the trajectory and calculated the initial velocity, assuming that the final vertical component of velocity was zero.

Question 27

This question tested students' understanding of forces in an accelerating system, particularly in respect of Newton's Second Law.

(a) (i) While most candidates were able to calculate the magnitude of acceleration, a significant number did not take account of the total mass of the system in their calculations.

(ii) The majority of students were able to apply Newton's Second Law correctly in order to obtain the correct answer.

(b) This question required an analysis by candidates in order to compare an actual situation with a frictionless one. Again, many failed to take account of the total mass of the system.

(c) This question required careful reading of the stimulus material and some practical knowledge of the design of the experiment; most candidates correctly equated the forces needed to calculate the angle with the horizontal. A significant number, however, incorporated previous answers incorrectly in their attempts to equate the forces involved, such as values for T or a.

Question 28

This was one of the more difficult questions; it required students to solve a two dimensional collision, given partial data of angles, masses and velocities.

The scaled diagram was the simplest method of solution and the majority of students who successfully completed the question used the sine rule after completing the correct vector diagram. Other more difficult techniques included analysis involving algebraic and trigonometric manipulation, with many students showing competence in these areas.

Many students could not provide a realistic diagram using vectors of momenta. Students, in determining the elasticity of a collision, often used momentum in calculations, indicating confusion between vectors and scalors.

Students generally need both to increase their skills in drawing vector diagrams to obtain solutions and to include a scale on their diagrams.

Question 29 (c)

This question examined the students' ability to draw graphs from tabulated data, interpret them and perform a simple calculation.

The graphing skills required for the question were demonstrated by the majority of students. A small number, however, did not make the most convenient choice of scale for their axes and some were confused by the term 'curve of best fit' and drew an 'average' graph of the plots of elements X and Y.

Most recognised that X did not obey Ohm's law and gave a valid reason for this. A significant number, however, gave a response that was so poorly expressed that marks could not be awarded in this section.

The majority of students, however, were able to determine the resistance of element Y.

Question 30

This question tested students' understanding of the forces on current-carrying conductors lying across a magnetic field, especially conductors with more than one turn. The question also showed how resolution of magnetic and gravitational forces may be used to determine the flux density (field intensity) of the field in which a conductor is placed. Students needed particularly to apply the skills of resolution of forces as vectors. In answering this question many showed a lack of skills in using calculators and manipulating algebraic expressions.

(a) The majority of students determined the correct direction of the force on the conductor. Some answered the question by using compass bearings without providing a reference symbol on the answer sheet.

(b) This question was not well answered. Some students misinterpreted α, not realising that it referred to a constant value: $\alpha = N I \ell$. Some used 'α = angular acceleration' while others used 'α = area'.

The majority of students failed to recognise the significance of the number of turns on the coil and, despite the reference in the question to force, many applied the torque formula. They also experienced problems in substituting the correct data into the formula.

(c) Students' answers to this question indicated that, while they recognised the relationship between the weight of the 8kg mass and the changed magnetic force, it was not well understood. They needed to use vector additions, with the magnetic force being reversed and balanced by the gravitational force.

The majority failed to determine and calculate the effect of reversing the current, while many failed to convert grams to kilograms. Others attempted to apply concepts of torque (from electric motors) to the balance beam. Students need to clarify the correct use of flux and flux density.

Question 31

This question required students to apply their understanding of refraction. It required the construction of situations involving wave fronts and rays so that the change in the speed of the wave was shown by the change in direction of the incident ray as compared with the reflected ray and a change in wavelength of incident wavefronts compared with refracted wavefronts.

Most of those who attempted the question scored some marks; many students appeared to have only drawn wavefronts in practice and their diagrams lacked the directional ray. Most saw these as being separate.

(a) A significant number of candidates did not provide a diagram showing both the new direction away from the norm and the wavefronts with an increase in separation.

The majority, however, either showed a direction away from the norm or an increase in wave front separation, and were able to indicate that refraction occurred.

(b) Most candidates who provided a diagram showing a progressive increase in refraction consistent with their answer in part (a) scored a mark. A surprising number of candidates incorrectly attributed an increase in velocity with refraction toward the norm.

Only a small number of candidates indicated the alternative correct response of total internal reflection or refraction at the critical angle.

(c) Very small numbers of candidates were able to provide the correct response in order to score the maximum marks. These answers clearly indicated continual progressive refraction until the critical angle was achieved or total internal reflection occurred, directing the thunder away from the ground, thus making it possible for the observer to see lightning without hearing the thunder.

Significant numbers of candidates indicated the continual refraction causing the ray they had drawn to refract away from the observer, failing to realise that equally valid alternative rays would be refracted toward the observer. Some candidates even showed the observer directly below the lightning, and so unable to hear the thunder, failing to appreciate the fact that a wave perpendicular to the medium boundary would pass straight through.

SECTION II – ELECTIVES

Question 32 A

History of Ideas in Physics

Half-Elective: Gravitation

(a) Students generally showed a sound understanding of the reasons for the rejection of the heliocentric model of Aristatchus by his contempories. Some students failed to appreciate the chronological aspect of the question and referred to events or the models of other astronomers after that of Aristatchus's.

(b) (i) Most students could provide a sound answer to this question.

(ii) Students showed a knowledge of how to construct diagrams demonstrating the motion of the sun using the geocentric system. The majority, however, could not apply their knowledge of epicyclic motion to demonstrate how the same motion could be created. Many related it to the motion of the planets, and not the sun.

(iii) and (iv) Most students could provide a correct response to both these questions.

(v) Students also generally provided a correct response to this question.

(c) (i) Most of the candidature could identify relevant features of the graph.

(ii) While most students achieved some of the requirements of this question, interpretation between values and missing powers were common errors.

Some students had difficulties in reading values from the graph provided. Others did not interpret the axes correctly or failed to appreciate the fact that values from the graph were already in the form T^2 and R^3.

Question 32 B

Half–Elective: Nature of Light

(a) (i) The majority of students knew the two differing models proposed in the 17th century to explain the behaviour of light.

(ii) Most students answered the question and attracted some marks for knowing a 17th century scientist. Some had difficulty in relating their chosen model to an explanation of a property of light, or had little knowledge of the chronological order of advances in the determination of the nature of light and named scientists from other times in their response.

(iii) Most students attracted at least some of the marks for this part, with many describing the double slit experiment.

(b) Most students possessed a good understanding of the contribution of Maxwell and the properties of light that are accounted for by his theory.

(c) (i) The majority of students understood and could describe what is meant by the work function of a metal. Some referred to threshold frequency.

(ii) A number of students had difficulty in answering this question, with some showing little knowledge of what an NM is and also in converting eV to J. Those who responded correctly to this question showed a good depth of understanding of the relationship between frequency and energy of light.

Question 32 C

Atomic Structure

(a) (i) Most students generally answered this question well. The most common error was confusing Lenard's experiment/model with that of Rutherford and/or Thomson. Many candidates used alpha particles as their atomic bullets. The question clearly asks for the experiment, the model and the results. Many students gave only a part answer e.g. Lenard's model.

(ii) This was also generally well answered but, again, confusion between models was evident. Most students correctly gave a similarity but many failed to distinguish between both models when giving a difference.

(iii) The broad scope of the question attracted a wide range of acceptable responses but less than half of the candidates managed this. Confusion between mass comparison and charge comparison was common.

(b) In general, this question was poorly answered, since many students failed to understand the relevance of the initial paragraph to the experiment.

(i) Some students misread the y-axis of the graph as being 'number of photons' and referred to 'photons' instead of 'electrons' in their response. The concept of electron energy levels was well understood, even though it was often misapplied in this question.

(ii) Here many students confused an energy level diagram with an electron orbital diagram.

(iii) Here a significant number read the energies straight off the graph.

(c) (i) This part was very well answered.

(ii) This was also fairly well answered, with a range of correct responses being offered, many of which indicated that the term 'physical parameter' was poorly understood.

(iii) This part was also fairly well answered.

Common errors included reading the wavelength straight off the graph or using a number taken from the graph as the wavelength in the calculation.

Question 33

Wave Properties of Light

(a) (i) This question required students to use wavelets to produce new wavefronts which changed direction in the glass. Most students were able to draw wavefronts and they correctly showed changed direction. Some students found it difficult to draw wavelets to show the correct location of wavefronts and many did not realise that there was a simple relationship between the velocity of the wave, the wavelength and the refractive index.

(ii) Here students were required to derive Snell's Law by using a geometric construction on their diagram. Those who correctly showed the connection between angles of incidence and angles of refraction and wavelength were able to find sine ratios and derive the law. Many students, however, did not appear to understand what was meant by the term 'derive', and instead, simply substituted values from their diagram into Snell's Law. This failed to score marks.

(iii) This question was well answered, with most students correctly computing the angle of refraction from the Snell's Law equation.

(b) (i) In general this question was well answered. Some candidates, however, did not indicate the path difference to the screen on their diagram nor discuss it in their answers. A number drew diagrams to show the formation of the central bright band only.

(ii) Most candidates had no difficulty in answering this question.

(c) (i) The majority of candidates had difficulty in realising that the bluish-red colour of the lens resulted from the absence of the yellow-green wavelengths in the light reflected from the coating on the lens.

(ii) Most candidates did not realise that the purpose of the coating was to maximise the transmission (minimise the reflection) of light into the camera.

(iii) This question was answered well, on the whole. Some candidates failed to identify the phase changes at the boundaries that would allow for maximum transmission.

(d) (i) The majority of candidates found this question difficult. Many responses referred to 'dispersion of separated colours' or 'refraction of blue and red light' with the most common explanation given stating that red light does not scatter and is transmitted directly to us. A large number of candidates referred to reflection of blue light from air molecules, while others talked about the reflection of blue light from the ocean and red from solid ground. The majority of those who were able to correctly discuss the scattering of blue light failed to provide a correct explanation of the removal of blue light from sunlight in explaining the red-yellow colour of the sunset.

(ii) The most common response to this question was that polarised light travels in one direction and unpolarised light travels in all directions. While many students showed understanding of the process of polarisation of light, they did not explain the difference between polarised and unpolarised light. In many cases the diagrams drawn showed the distinction but the explanation that accompanied them was incorrect.

(iii) A significant number of students did not attempt this part of the question and those who did so had difficulty in understanding what was meant by 'the vertical arc from west to east'. Some candidates compared the polarisation effects from west to east where reflection of light off the polaroid might have happened. A large number of candidates drew an intensity versus position graph. Some were under the impression that this question related to (d) (i) and (ii) and talked about the connection between scattering and polarisation. Most students described the shape of their graph instead of justifying its shape.

(e) (i) This question was generally well answered. A number of candidates used sound instead of light for the explanation, but showed a good understanding of the concept. Those who did not understand the concept talked about change in brightness or loudness as a result of relative motion of the source and the observer.

Question 34

Rotation

This question was well answered by most students. Many experienced difficulty in satisfactorily answering the descriptive parts but scored considerably better on the mathematical responses. A significant number were careless in converting units and making substitutions into known equations.

The question involving precession was well done and indicated a sound understanding of the physical concepts involved.

(a) (i) This was well answered, but simple errors spoilt many results.

(ii) The reason for the reduced torque in an accelerating system was not well explained by many students.

(iii) In answering this question, errors were made by a large number of candidates, with many comparing the moments of inertia of the two systems or the angular accelerations, but not the times involved.

(b) In answering this question, students needed to draw precise and clear diagrams with the correct vector orientation.

(c) This question was very well answered. The fact that the rotational kinetic energy increases was often explained in terms of energy (kinetic to rotational) rather than in terms of angular momentum and angular velocity.

(d) Many students experienced difficulties in explaining relative rotational velocities.

Question 35

Physics in Technology

A Half-elective: Engineering Materials and Structures

(a) Most students were able to relate the advantage of lifting or throwing to an increase in torque. The better students calculated moments using values from the diagram to show that athletes with an extended muscle contact point need to apply less force than the non-athletes to balance the clockwise moments.

A significant number of candidates attempted to answer the question without referring to the diagram. A small proportion of students attempted to solve the problem by assigning values to the masses, forces or weights.

(b) (i) The majority of candidates showed in some way that they understood CM = 0 and were able to determine the weight of the truck.

(ii) Fewer students correctly determined the weight of the submarine. Errors commonly involved omitting values for distance. A significant number of candidates made mistakes in the process of cancelling x in their equations.

(iii) Candidates generally failed to understand centre-of-mass and most had difficulty with the concept of non-specific horizontal location. Several who correctly determined the horizontal location, described a specific point as the centre-of-mass, which very few placed below the point of contact of the main support string. Only two candidates gave it a general position along a vertical line below the point of contact of the main supporting string. A small number of students attempted to apply the centre-of-mass equation but most failed to produce adequate answers.

(c) Most candidates were able to apply the Young's modulus formula correctly. A significant number, however, made mistakes when converting length values to common units.

(d) (i) Many candidates were able to produce a cross-section of the shelf showing compression at the top and tension at the bottom. While some indicated clearly that there was zero stress in the middle, only one candidate clearly indicated that there was a gradation to zero stress in the middle of the cross-section.

(ii) Most candidates correctly suggested that the support timber should be placed below the shelf with the better candidates supporting their descriptions of the location of the support timber with a diagram. The majority did not justify their answers with an explanation. Those who did so, rarely referred to rigidity or stiffness.

Question 35 B

Optical Instruments

(a) (i) This part was generally well answered with very few students confusing the Cassegraine with the Neutonian telescope. Labelling, however, was often insufficient and few students located the image (primary or secondary).

(ii) Most students were able to list two advantages of the Cassegraine telescope although some answers were not sufficiently specific.

(b) (i) This part was generally well answered. The only recurring error was inability to specify that inversion was lateral.

(ii) Only a few students were able to complete the ray diagram successfully to show how the sign would be seen.

(iii) This part was generally well answered.

(c) (i) Most answers here were good, although many students wrote a formula without specifying the meaning of the symbols.

(ii) Ray diagrams were particularly well done in most cases.

(d) A majority of students displayed a good understanding of chromatic aberration. The better students were able to relate the different refraction indices of the component lenses to the way in which this type of aberration is corrected.

Question 35 C

Transformation of Energy

The majority of those who attempted all or part of this half-elective gained some marks.

(a) Although many candidates could determine the total power output of the Christmas lights, a substantial number had difficulty in applying the efficiency equation to determine the power input of the transformer.

A number of candidates appeared to be confused by the term ‘consumption’. The majority could determine the time and total energy, but were unable to convert this to kilowatt hours. Most, however, were awarded marks for showing their calculation of the cost.

The majority of candidates could identify the fact that heat was lost in the transformer, but could not state that the reason for this was the internal resistance of the transformer. Many associated the voltage drop with energy loss, giving this as the reason for the energy difference, or described the loss of energy by the lights or connecting wires.

(b) The better candidates identified the change from chemical to heat energy and the fact that mass was converted to energy. The majority of candidates, however, gave all the energy transformations of a power station, often starting with heat and ignoring the chemical energy in coal; they also stated that uranium is the source of nuclear energy.

It would seem that many candidates had a poor understanding of the Preliminary Course on Nuclear Physics; the more able students, however, showed a sound knowledge of the energy conversions within a working power station and could give a description rather than a simple statement.

Many candidates described the global problems of each energy source rather than focusing on those within the power station itself.

(c) This was the best answered section, since candidates were able to demonstrate their knowledge of Joule's experiment, partly because of the stimulus material.

To determine the heat gained by the water, many did not use the definition of a calorie given in the stimulus material. Many used the enthalpy equation and the specific heat of water given on the data sheet.

Most students could use their answers to parts (i) and (ii) to find the mechanical equivalent of heat.

In the mathematical parts of the question, many more students would have gained more marks had they written the relevant equation and shown their substitution.

Question 36

Astronomy

(a) Almost all students gained most marks for this section. Some students demonstrated a poor understanding of the term 'label' and of how to write an acceptable abbreviation.

(b) In (i) and (ii), while a number of students demonstrated understanding of the definition, they simply recited information without referring explicitly to the detail in the question.

A significant number confused brightness with the scale of magnitudes. Most students correctly identified the fact that stars would be closer, and therefore less bright; they then stated that the absolute magnitude would be less.

(iii) Students experienced difficulty relating the 'previous mass' to a new 'estimated mass'.

(iv) Few students who attempted this question gained full marks. A major source of confusion in answering this question was that globular clusters are described as 'old stars'. Students confused the concept of relating 'younger than previously thought' with 'containing young sites'.

Many candidates referred to the Stubble experiment and described stars further away as being older.

(c) Most students failed to provide a clear reference to the direction of relative motion in the Doppler Shift, and very few used a diagram while most of those who did so, scored marks.

(d) (i) While a number of students realised that there is an imbalance between the forces, a significant proportion had difficulty explaining correctly the nature of this disequilibrium in terms of gravitation and radiation pressure.

(ii) A high cognitive level was required for a complete understanding and correct explanation of the question.

This question was poorly answered, since most candidates stated incorrectly that the luminosity of a cepheid star increases with increasing radius, failing to appreciate the relationship between its luminosity and temperature ($L\mu R^2T^4$) as the radius decreases with a resulting increase in the rate of reactions.

(iii) More than half of the candidature gained full marks in this section, correctly describing the characteristics in terms of temperature, colour luminosity, radial velocity, etc. Many gave calculated characteristics or used terms which were difficult to accept as being actual physical characteristics, with statements relating to colour index, heat, absorption spectra, apparent magnitude, etc. Many simply stated terms used in the question or their answers were directly attributed to volume, surface area or gravitational pressure.

(e) (i) While most candidates showed an understanding of the evolution of a massive star, many failed to gain full marks by giving brief statements rather than an extended response or discussion as expected by the question.

Most students realised that the mass was greater but did not state that it was much greater or estimated a mass <50 solar masses. Most did not state that the luminosity was related to mass.

(ii) The majority of students correctly stated this was a young star but did not gain the second mark because they failed to explain the relationships between reaction rates and the mass of the star.

(iii) This was well answered with most stating correctly the final state of the star as a super-nova – black hole. However some students simply used terms such as ‘big’, ‘much bigger’, ‘very big’, ‘greatly bigger’ without providing any specific comparison.

Many students tried to cover all bases by writing everything they knew, rather than simply answering the question.

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