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Report on the Examination in

SCIENCE: PHYSICS

Syllabus Code 1700

SUMMER 1994

PHYSICS

(Syllabus Code: 1700)

GENERAL INTRODUCTION

The percentage of candidates awarded each grade was as follows:

Grade	A*	A	B	C	D	E	F	G	U
% in grade	9.5	17.8	21.0	29.3	12.0	6.2	2.6	1.0	0.6
Cumulative %	9.5	27.3	48.3	77.6	89.6	95.8	98.4	99.4	100

These statistics are correct at time of publication.

The total number of candidates was 13995.

All candidates take Paper 1, Paper 2 and Assessment of Practical Work (component 4), and grades C – G are awarded on this part of the examination. Paper 3 is optional and is intended to discriminate between candidates of higher ability.

Grades A and B are awarded on the basis of performance on Paper 3 together with component 4, with Paper 3 carrying a weighting of 80% of the total mark for this part of the examination. To qualify for the award of A or B, candidates have to gain grade D or better on the compulsory components of the examination.

PAPER 1

The correct response to each item was as follows:

Item	Correct Response	Item	Correct Response	Item	Correct Response	Item	Correct Response
1	D	11	E	21	E	31	D
2	C	12	A	22	E	32	E
3	A	13	C	23	D	33	D
4	D	14	E	24	C	34	A
5	B	15	A	25	C	35	E
6	B	16	B	26	C	36	A
7	E	17	B	27	C	37	B
8	B	18	C	28	B	38	E
9	D	19	C	29	D	39	A
10	B	20	E	30	C	40	A

PAPER 2

All questions proved to be effective in discriminating across the full range of ability taking this paper. Most questions provided adequate opportunities for candidates at the lower end of the ability range to demonstrate their knowledge and understanding of the subject matter.

Question 1

This proved to be a suitable first question with most candidates being able to score some marks.

(a) Most candidates were able to earn marks in this part, although there was some confusion as to what was happening from B to C.

(b) 'Gravity' was an answer which was seen frequently.

(c) Some candidates *described* the motion between B and D and did not refer to the forces acting on the parachutist.

(d) Most candidates were able to gain full credit in this part although a small minority thought that she opened her parachute at E and consequently lost both marks.

Question 2

(a) A standard text book answer would have been acceptable for this part. However, most candidates did not refer to the value of the force. There were also several answers which referred vaguely to *leverage*. Vague references to the *length of the spanner* were usually incomplete.

(b) Curved arrows were common but usually at least one of them did not start on a hand. There appeared to be little confusion between clockwise and anticlockwise.

A *small (diameter) wheel* was a common incorrect answer to part (b)(ii).

Question 3

(a) Providing the formulae was not a guarantee that candidates got the correct answer! It was pleasing to note that many did show their working and in this case it proved helpful in awarding marks. Many clearly showed that they had divided by 1 minute and earned credit for this. There was some confusion in units with N/m being given as a unit of work and J as a unit of power.

(b) In part (i) some candidates had difficulty in expressing themselves accurately unless they confined their answers to correct statements about Hooke's law.

Question 4

There appeared to be some guessing as to the correct term for the heat transfer processes in parts (a)(i) and (b)(i) and (b)(ii).

In part (a)(ii), correct descriptions and/or explanations of the process of conduction scored no marks.

The word *convection* was given by many candidates but there was usually an incomplete explanation of the process. Reference to the *water becoming less dense when heated* usually was not given even by candidates scoring the highest marks.

Question 5

(a) A common incorrect answer to this part was *high frequency electromagnetic waves which reflect off solids.*

There were good answers to most other parts with the chart causing very few problems. A unit of m/s was seen occasionally in the answer to part (e).

Question 6

The fact that there was little space under the diagram did not appear to cause the candidates any difficulty. The voltmeter was either drawn in the small space or placed on the inside of the circuit. The spelling of voltmeter as two separate words (volt meter) was relatively common.

The calculation in part (a)(iii) was usually well done and with the correct unit given.

Answers which were the wrong way round in part (a)(iv) were not uncommon and this led to problems with part (a)(v). The idea of direct proportionality between resistance and length was known to some candidates although their powers of expression often limited the extent to which they conveyed this.

(b) In this part, many candidates did realise that the resistance was increasing and in some cases stated that calculations based on data from the graph would prove this. However, not all of them did the calculations. It was sufficient to state that the gradient of the graph was increasing with increasing current.

Question 7

(a) Once again examiners have commented on the relatively large number of candidates who have no idea of the colour code. There were also many examples of the old code in use.

(b) The use of the long Earth pin to open shutters over the live and neutral was not as widely known as expected.

(c) There were many vague statements about the need for wires to be *connected correctly* or *connected properly* without an adequate explanation.

(d) Some candidates may not have realised that the metal case of the heater was connected to Earth.

Answers which referred to *electricity* rather than to current were not acceptable for full marks.

A carefully structured answer which stated that the fuse melted because a large current flowed to Earth scored two marks. The third mark was for stating that the live was disconnected as a result of the fuse melting.

Question 8

(a) The effect of a d.c. on the coil of a loudspeaker was not known by many.

(b) A description of the difference between an a.c. supply and a d.c. supply in terms of the **direction** of flow was infrequent.

Whilst most realised that the a.c. supply of frequency 1000 Hz would make the cone vibrate, many did not realise that this would produce a continuous tone.

(c) Examiners were expecting candidates to say that a quieter note of lower pitch would be obtained.

Question 9

(a) There was some confusion between the alpha-particles and the ions but, in general, adequate descriptions were given.

(b) A common incorrect answer was that gamma ray sources were *stronger* and therefore more dangerous.

(c) There was confusion between plates X and Y, the positive and negative of the supply and the direction of motion of the ions in some candidates minds. The fact that the ions moved in clearly opposite directions earned some credit.

(d) A variety of ingenious ways of causing the alarm to go off were invented. The introduction of a spider appeared popular as did placing a sheet of paper over the radiation source.

(e) Most candidates recognised the economic factor.

(f) *Heat rises* was a common answer which was unacceptable.

(g) Most candidates realised that the alpha-particles could not penetrate the case.

Question 10

(a) Most candidates were able to get this correct but some credit was also given for Q being the inverse of A.

(b) The examiners were looking for answers in terms of the door being open or closed and the LDR being in the light or dark.

One pair of correctly matched conditions scored 2 marks with the third mark for another correctly matched pair. The other mark was awarded for a clear statement that the logic level of output Q had to be 1 for the buzzer to sound.

PAPER 3

The comments which follow relate to the work of the candidates for whom the paper was intended, those seeking grades A*, A and B. There were as usual some centres who entered large numbers of weak or ill-prepared candidates for this extension paper. These candidates were often unfamiliar with interference of waves, the bistable latch and some aspects of radioactivity so were unable to answer the questions on those topics well. Very good answers were seen to all parts of the paper though full marks on the optional questions were rarely obtained this year. The lower proportion of calculations in this year's paper relative to last year's contributed to the lower scores generally obtained. Most candidates were able to complete the paper but there were a few who wrote unnecessarily long answers who found themselves short of time at the end. Although, in part A, candidates are not penalised for writing beyond the dotted lines provided, they should be encouraged not to do so if they can help it. The number of lines provided is an indication of the length of answer expected, as is the mark allocation. Experience shows that if we provide more than enough lines some candidates feel they all have to be filled! The examiners can't win.

Question 1

This question tested the understanding of the formation of a real image by a converging lens in the context of a slide projector. Nearly all candidates read the stem of the question carefully and drew rays from the slide through the converging lens and onto the screen, the other components being ignored. However, they usually showed only one ray from X and one from Y reaching a suitable place on the screen; they did not show how the image was focused. This required at least two rays from X being drawn to focus at a point on the screen and, for full marks, two from Y as well. Simple answers were expected to the remaining parts of the question, *the lens is closer to the slide than to the screen* being sufficient to explain why the image is larger than the slide. It was, however, not enough to say *the lens is a long way from the screen.* Alternatively candidates could make sensible reference to the geometry of their ray diagrams.

Question 2

This question was about the forces on a rod suspended in a tank of water. Calculation of the force exerted by the water was usually correct. Most candidates stated that the water pressure increased with depth but had difficulty in making it clear that the water pressure caused an *upwards* force on the base of the rod which therefore caused the reading on the meter to fall as the rod was lowered. Some felt the effect was caused by the water pressure acting on the sides of the rod.

In part (c) candidates had to calculate the length of rod immersed when it floated. Plenty of correct answers were obtained, usually by saying 1 N upward force was obtained per 5 cm under water, so 5.4 N required 27 cm. Many then went on to say that the assumption they had made was that the water pressure was constant at all depths, whereas they had just assumed it increased in direct proportion. Some even wrote *the pressure is constant at all depths even though it really increases with depth.*

Question 3

It is regretted that an erratum slip had to be issued for this question. Curve Y should have been labelled *force exerted by the engine on the train* to agree with the wording used in the sentence immediately above the graph. It is not thought this caused any problems to candidates.

Weak candidates were reluctant to *use the curves* to explain why the acceleration decreased and many candidates only referred to one of them. The calculation proved a good discriminator, since candidates had to find the resultant force (88 kN) from the graph before substituting in $F = ma$. Many chose 100 kN or 12 kN. They also had to cope with the force being in kN, not N, and to end with an appropriate unit for acceleration. Note that although m/s/s was credited it is an ambiguous unit; m/s^2 is preferred at this level.

Candidates usually deduced the maximum speed of the train to be 50 m/s but they were reluctant to say simply that this was when the force exerted by the engine on the train was equal to the resistive force on the train. They preferred to try to say what would happen if the train went any faster, a situation which would be impossible. One even claimed that if it went any faster it would be going backwards. The final calculation on the power of the train at 50 m/s was often well answered, many candidates combining the equations for *work done* and *power* quite successfully. They usually considered the work done in 1 second. Again there was a problem with the force being in kN and some used the weight of the train to calculate the work done rather than the force exerted by the engine on the train (40 kN).

Question 4

This question on interference was better answered than in previous years, perhaps because a very similar question was set in summer 1993. For full marks we expected candidates to explain that at P the waves arrived in step and so constructive interference or reinforcement of the waves occurred whereas at Q the waves were out of step and cancelled one another out. If these points were not all clearly made an alternative mark could be scored by pointing out that the paths to Q differed by half a wavelength. Part (b) of this question was not well answered – the last part was intended for the A* candidates to show their mettle. Too few answers specified that the wavelength was halved, rather than just reduced, and fewer then showed that as the waves would now reach Q in phase there would be a trace of (approximately) the same amplitude as X as well as of double frequency.

Question 5

The explanation of the rotating magnet dynamo which we looked for was that there was a changing magnetic field in the coil which caused electromagnetic induction in the coil. Common errors were statements that the effect was caused by the coil becoming a magnet or statements which failed to make it clear that the field was changing or linking the coil. The sketch graph of two cycles of the waveform was usually correctly drawn. Most candidates could say that when the bicycle was ridden faster the current increased and the lamp got brighter but they did not relate this to the increased rate of change of the magnetic field through the coil. Some stated that the frequency of the current would increase but it was rare for all three marks to be obtained.

The most successful answers to the last part were those in terms of energy which were usually only given by the most able candidates. *Extra energy has to be supplied to light the lamp.* Those who wrote in terms of forces had difficulty specifying the forces clearly. Answers in terms of Lenz's law were not expected as that law is not in the syllabus but they were given credit when seen. With hindsight, the question would have been better if it had specified that the dynamo was already turning before the lights were switched on.

Question 6

This question was about an alarm circuit using a bistable latch. Some groups of candidates had obviously not been taught about latches and so many answers of part (a) expected the noise from the buzzer to be in proportion to the level of the lighting. In fact it will be constant and remain on until the switch P resets the latch. Part (b)(ii) was probably the hardest part of the whole paper. Few candidates made it clear that copper wire has a very low resistance. The A* candidate was able to say that the switch and resistor were needed to provide a potential divider to give a 0 or 1 logic input to input B. Most others incorrectly thought that the presence of the resistor made sure the current went into B when the switch was pressed.

The later parts were often done better, as familiarity with the latch was not needed. Some candidates gave more than one answer to (d) but in doing so sometimes shot themselves in the foot. Acceptable answers were either to increase the value of resistor R or to replace the LDR with a different one which had a lower resistance. Some answers were spoilt by not specifying clearly which component was being changed or in what way it was being changed.

Part B

Question 7 was most popular and 9 the least, but the three questions were well matched and candidates did equally well (or badly) in all three.

Question 7

This was about a hair dryer. The power was usually correctly calculated. However the resistance of an element of half the diameter was usually reckoned to have been doubled rather than being multiplied by 4. Again the A* had a chance to shine. Circuit diagrams were often basically correct, many candidates realising the motor and heater needed to be in parallel. A mark was sometimes lost through not indicating the live wire of the mains supply and so not showing that the switches and fuse were on the live side. Some candidates thought the question was a logic problem, which in a sense it was, and included AND and OR gates. These cannot be used with 240 V a.c. mains.

To obtain full marks in the last two parts of the question answers needed to be more detailed than some candidates considered necessary. Although most stated that the dryer without a motor would overheat dangerously fewer made clear the function of the motor in driving a fan which moved air through the dryer. Some said *the motor blows the heat out* which was not given credit. The significance of the statement that the dryer was double insulated was lost to many candidates or taken to mean that it would overheat easily. One correct answer was to say that if the live wire became loose and touched the neutral wire a larger current would then melt the fuse. Those who had the live wire touching the (non-existent) earth could score 1 out of 2. It was not enough to say that *a short circuit occurred* without further explanation and wrong to say that overheating caused an increase in current.

Question 8

A common failing of answers to this question about the kinetic theory of matter was for the mechanisms of the processes to be very sketchily described. A clear picture of molecular movement and its effects did not always emerge. Most could identify the diffusion process in (a) but naming it, although given 1 mark, does not explain it. A description of molecules (or ions) moving about colliding with one another and so slowly mixing was not often given by the weaker candidates.

The density calculation was often correctly worked out. As with other calculations part marks could be obtained for incorrect work provided, in this case, examiners could see evidence that showed mass being divided by volume.

Good candidates realised that the information about melting and boiling points showed that the propane in part (b) was a gas at room temperature. To get full 5 marks they could first explain that the molecules were moving in all directions (at random). This was usually taken for granted by the candidates. They then could say that heating the gas increased the speed of the molecules which caused them to hit the **piston** more often **and** harder and that this caused an increase in pressure which would push the piston up. A common answer was *the faster molecules need more room to move in and so the gas expands*. This would have scored 1 mark only, for saying the molecules moved faster. In the final part a good many candidates failed to use the melting and boiling temperatures to deduce that the propane would become a liquid and then a solid. It was hoped that a comment on the very large overall volume change would be made or other sensible comment on the volume changes at particular stages in the process.

Question 9

This question on radioactivity and nuclear physics was more popular with some centres than others. Confusion between the meanings of the words *atom* and *nucleus* was sometimes apparent in part (a) but generally the answers were correct but tending to be incomplete. The very small size of the nucleus relative to an atom was not always made clear (a pea at the centre of Wembley Stadium gets the scale about right).

In part (b) the usual confusion between *radiation* and *sources of radiation* was apparent. The alpha particles were often thought of as gas molecules, becoming concentrated in the unventilated building and being breathed in. The best answers made it clear that the *radon* was breathed in and that the alpha radiation, which is an ionising radiation, could then cause damage to cells in the lungs resulting in diseases such as cancer.

The final part of the question, estimating the time taken for 99% of a sample of radon-220 to decay, was often correctly solved. The better candidates started with 100 atoms and halved away until they got to less than 1 after the seventh division, so reaching an answer of about six and a half half-lives. The weaker ones made life hard for themselves by starting with 220 rather than 100 but often ended up with the correct answer. A few mathematically literate wrote $(0.5)^n = 0.01$ and were able to solve for n using trial and error on their calculators or sometimes even using logarithms! How different from the mathematical nonsense that so often appeared:

$$\frac{100}{2} = \frac{50}{2} = \frac{25}{2} = \frac{12.5}{2} = \frac{6.25}{2} = \frac{3.125}{2} = \frac{1.56}{2} = 0.78$$

Answers to numerical questions

In all questions equivalent forms of these answers are accepted; e.g. 2000 kW; 2 MW; 2×10^6 W.

2 (a) 3 N
(c) (i) 5.4 N
(ii) 27 cm

3 (b) 0.22 m/s^2
(c) 50 m/s
(d) 2000 kW

6 (c) 200 ohm

7 (a) 1600 W
(b) 144 ohm

8 (a) (ii) 1.08 g/cm^3

9 (b) (iv) 370 s (allow 350 s to 392 s)

INTERNAL ASSESSMENT OF PRACTICAL WORK

Introduction

The trend towards closer agreement between Internal Assessors and External Moderators continued again this year with fewer centres having their marks changed than in past years. The tendency was still to overmark rather than undermark for those centres that were changed.

Centres generally followed the instructions issued by the Group and the material was made available to moderators by the requested time. There were still a few errors either in arithmetic or transcription, and some centres were unfortunately using old mark sheets asking for totals out of 48, instead of the 96 plus 5. Spelling, punctuation and grammar were marked for the first time on this paper, and whilst from the limited evidence available this mark was acceptable, there was some indication that a few centres were reluctant to award the full mark of 5 when it was justified. Where assessors failed to put a mark for SPAG on the script moderation was made more difficult.

Skill A. Using and Organising Techniques, Apparatus and Materials.

This skill continued to score the highest marks, but these were justified from the samples submitted. A few cases of skill A and skill D, or all four skills being marked on a single piece of work were noted.

Skill B. Observing, Measuring and Recording.

There was close agreement on the marking of this skill between Internal Assessors and External Moderators, and very few cases where outline or detailed format was given necessitating a reduction in marks. No use of Circus of Measurement for skill B was reported this year.

Skill C. Handling Experimental Observations and Data.

Again close agreement was found, and most centres used at least one investigation involving a graph for this skill. However, some centres correctly required candidates to interpret these graphs or take readings from them for the higher marks, whilst others did not require this, resulting in a reduction of the mark. Most centres now understand the penalty introduced for outline or detailed format in this skill, and no moderators reported the use of second-hand data this year.

Skill D. Planning, Carrying Out and Evaluating Investigations.

Once again the majority of the changes necessary were in this skill area, and resulted particularly from the lack of evaluation offered by candidates. There were still some centres that gave exercises where little planning was required. The open-ended investigation is still found to be the best for assessing this particular skill.

Whilst many of the standard exercises were in evidence, probably because they had worked well in the past, there were some centres that used extended investigations more along the lines of National Curriculum Sc1 requirements. Where detailed annotation was made on exercises it did help considerably in the moderation process.

General

It was pleasing to see the convergence of standards between Internal Assessors and External Moderators once again, but sad to know that this is the last year of this particular exercise. Commercially produced material was used selectively with the MEG criteria in mind, and though a number of centres still used a type of tick list, they did in general give a mark in line with that of the criteria. It would appear that practical work is now firmly established in the Physics courses, and this augurs well for the replacement curriculum.

GRADE THRESHOLD MARKS

Credit of up to 5% of the unscaled marks was awarded for spelling, punctuation and grammar in components 2, 3 and 4. In the table giving the Component Threshold Marks, which follows, the respective component maximum mark totals include these marks for spelling, punctuation and grammar.

Candidates' performances were assessed on each component. The minimum level of each performance (the threshold mark) was determined for each grade. These thresholds are given below as unscaled marks (i.e. the scale of marks used by the Examiners).

The relevant component thresholds were then related to each other in accordance with their component weighting to fix the overall threshold marks for each option. Each syllabus mark is shown as a percentage.

COMPONENT THRESHOLD MARKS

Component	Maximum Marks	A	B	C	D	E	F	G
1	40	–	–	30	27	24	20	18
2	84	–	–	57	48	41	34	26
3	84	52	42	–	–	–	–	–
4	101	88	77	66	56	46	37	28

SYLLABUS THRESHOLD MARKS

Components	%	A*	A	B	C	D	E	F	G
1, 2, 4	100	–	–	–	70	61	53	44	36

Components	%	A*	A	B	C	D	E	F	G
3, 4	100	76	65	55	–	–	–	–	–

* Summary of results by Option:

Option A (Components 1, 2, 4)

Total completed entry 1266.

Grade	A*	A	B	C	D	E	F	G	U
% in grade	–	–	–	18.2	27.2	25.4	16.3	7.7	5.2
Cumulative %	–	–	–	18.2	45.4	70.8	87.1	94.8	100

Option B (Components 1, 2, 3, 4)

Total completed entry 12730.

Grade	A*	A	B	C	D	E	F	G	U
% in grade	10.5	19.5	23.1	30.4	10.5	4.3	1.2	0.3	0.1
Cumulative %	10.5	30.0	53.1	83.5	94.0	98.3	99.5	99.8	100

* These statistics are correct at the time of publication.