PTF_HT26_06

Examiners' Report for Physics, and Physics & Philosophy, Prelims 2025

171 candidates sat the Physics papers in early June. 18 candidates were entered for Physics and Philosophy papers.

Detailed mark breakdowns follow for individual papers are given for Physics cohort. In line with the University requirement that the mean mark on each paper must be 65%, a simple linear re-scaling was applied to the marks for CP1, CP2 and CP3 but CP4 marks remained unscaled. The pass mark for all four papers was 40.

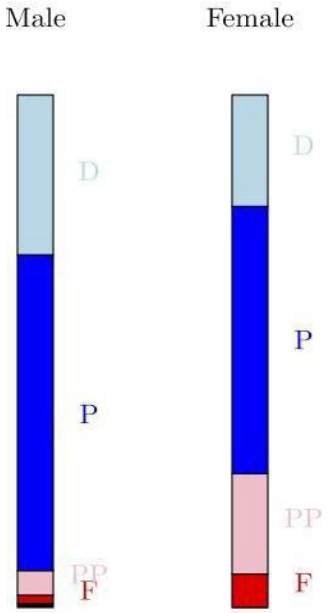
Checkers examined all scripts to ensure that all marks were correctly totalled.

All mitigating circumstances applications were considered and, where evidenced, were taken into account.

The Physics Prelims Examiners awarded 49 distinctions for distinguished performance across all four core papers such that performance in each paper was required to be greater than a number close to the mean for the paper, and with their average mark greater than or equal to 70 marks. Prizes for best performance across all four core papers were awarded irrespective of their ranking within the cohort.

The Prelims Examiners also commended 8 candidates for top performances in individual core papers. For Practical work, 6 candidates were awarded prizes and a further 18 were commended. The Physics and Philosophy Prelims examiners awarded two distinctions to candidates who demonstrated excellence in both subjects.

The Examiners note a continued downward trend of examination technique (candidates failing to define the quantities they used, poor or poorly labelled diagrams etc.). Again, many of candidates ignored instructions about use of the answer booklets, in some cases distributing parts of their answers in various places throughout different booklets.



The breakdown of Distinctions (D), Passes (P), Partial Passes (PP), Fails (F) and Withdraws (W) for males and for females is tabulated below and depicted left.

The Physics Prelims Examiners note the performance of both males and females for distinctions and passes are not consistent with the cohort ratio.

	Physics			Physics and Philosophy		
	M	F	Total	M	F	Total
D	39	10	49	2		2
P	77	24	101	5	5	10
PP	6	9	15		5	
F			5			
W						
	125	46	171	8	10	18

Numbers less than 5 for F and W are not reported

Related to the matter of comparative performance for females and males in Prelims, the Prelims Examiners last year and this have considered the merits of making a change to Section B such that it would contain only three long questions (20 marks each) that should be attempted by all candidates. (The current situation is that Section B on each of these papers has four questions of which three should be attempted.) We have identified three advantages of this approach:

1. It would discourage attempts to "game" the exams by ignoring a portion of the syllabus in order to concentrate on the rest of the syllabus ignoring optics completely in order to focus on electromagnetism and being able to choose a Section B question not requiring optics knowledge. We do not think consider gaming is healthy for candidates (especially in this foundational year of their Oxford Physics degree course) or for the subject.
2. We think we would be more likely to obtain a fairer ranking of the candidates if they all sat the same questions, rather than having a random element thrown in because they were not tackling the same questions.
3. Candidates will spend time getting on with thinking about the questions rather than deliberating over which ones to tackle.

September resits: There were 19 candidates for Physics entered for one or more papers, 13 passed. For Physics and Philosophy, there were 6 candidates entered for one or more Physics papers, and five passed.

The Physics Prelims Examiners 2024-2025:
Katherine Blundell (Chair), Michael Barnes, Philip Burrows, Andrew Wells

The Physics & Philosophy Prelims Examiners 2024-2025:
(Katherine Blundell (Chair), Philip Burrows, James Read, Alexander Paseau)

CP1 June 2025 paper

1. Overall remarks

There were no problems reported with the paper. The average mark was slightly higher than the target so a rescaling factor was applied. The section A questions were straightforward and generally well done. The section B questions proved to be more challenging.

2. General statistics – Physics students

Average mark (rescaled)	65
Top mark (rescaled)	88
Standard deviation (rescaled)	15
Number passing (> 40%)	161
Number passing with >70	52
Number failing (< 40%)	11

3. Comments on Section A (unscaled marks)

A1. Mean 6.2/7, sd 1.6. A standard problem on moments of inertia that was generally well attempted.
A2. Mean 3.5/4, sd 1.0. A standard 1-dimensional projectile problem that was generally well attempted.
A3. Mean 4.9/6, sd 1.8. A standard problem on relativistic kinematics that was generally well attempted.
A4. Mean 3.5/4, sd 1.1. A standard 'bookwork' collision problem that was generally well attempted.
A5. Mean 3.3/4, sd 1.2. A standard problem on potential energy and circular motion that was generally well attempted.
A6. Mean 4.2/6, sd 1.3. A standard electrostatic problem on distance of closest approach that was generally well attempted.
A7. Mean 6.4/9, sd 2.7. A standard problem on Lagrangian mechanics that was generally well attempted.

4. Comments on Section B (unscaled marks)

Q8, 156 attempts, mean 15.9/20, sd 4.2. A standard problem on special relativity and Compton scattering. The main parts were essentially standard derivations and were largely well done. The last part of (c) 'Interpret physically…' seemed to tax some candidates.

Q9, 142 attempts, mean 11.4/20, sd 4.2. A standard 2-dimensional problem on Lagrangian mechanics applied to a rotating rod system. The first three parts were generally well attempted but part (d) proved more challenging for a significant number of candidates.

Q10, 120 attempts, mean 12.8/20, sd 4.9. A standard problem on central forces as exemplified by satellite motion. The algebra in part (c) was mildly tedious and defeated many candidates.

Q11, 95 attempts, mean 8.3/20, sd 5.7. This was the least popular and most poorly attempted question. A deceptively simple problem on two-body elastic collisions in one dimension, which proved to be a good discriminator among candidates. A good fraction of candidates understood the problem and achieved near-full marks; the main cohort went awry on part (b), having failed to draw correctly the sequence of collisions of the two balls.

5. **Comments on the September 2025 resit**

10 Physics candidates sat the paper, of whom 2 failed to reach the pass mark of 40%. The remaining candidates passed comfortably.

CP2 June 2025 paper

1. Remarks

There were no problems reported with the paper.

Consistent with the trends seen across the board, exam technique was poorer than last year in terms of candidates not defining the terms they used and not explaining their working, and poor or no use of sketches/diagrams.

The mean mark was slightly higher than the target mean mark, so a simple rescaling factor was applied. The electromagnetism questions stretched the candidates a little more than last year; for some candidates, some of the optics/circuits questions in Section A were not well tackled again raising possible suspicions that in some cases students may be selectively preparing only parts of the syllabus.

2. Simple statistics (scaled marks)

Average mark: 65

Standard deviation: 14

Top mark: 84

Lowest mark: 9

Number passing (>= 40%): 161

Number passing with > 70%: 68

Number failing (< 40%): 10

3. Comments on Section A (unscaled marks)

Qn 1: 1 Number of attempts: 169; Mean mark: 5.1; std dev 1.6
Most candidates got stuck into this nice question and did well. Despite the final instruction in this questions, a majority didn't state any of their assumptions.

Qn 2: Number of attempts: 169; Mean mark: 3.5; std dev 1.0
A remarkable number of candidates seemed to neglect the inductance of the wire loop (introduced in the first sentence) as a term in the impedance.

Qn 3: Number of attempts: 168; Mean mark: 4.9; std dev 1.8
Many candidates who attempted this question scored high marks.

Qn 4: Number of attempts: 169; Mean mark: 3.5; std dev 1.1
Poor exam technique hindered a number of candidates from seeing clearly through this question.

Qn 5: Number of attempts: 168; Mean mark: 3.3; std dev 1.2
The candidates who struggled with this question lacked a good grasp of the relevant definitions.

Qn 6: Number of attempts: 169; Mean mark: 4.2; std dev 1.3
This question was answered well by those candidates who could draw a clear diagram.

4. Comments on Section B (unscaled marks)

Qn 7: Number of attempts: 158; Mean mark: 15.9; std dev 4.2
An enjoyable question for many candidates, favouring those who kept track of which angle was which together with the relevant optics laws.

Qn 8: Number of attempts: 142; Mean mark: 11.4; std dev 4.2
Many students floundered with the differential equation and in keeping all the pieces of information from the earlier part of this question in mind as they attempted labelled sketches of the different currents.

Qn 9: Number of attempts: 120; Mean mark: 12.8; std dev 4.9
A remarkable number of candidates don't seem to understand the difference between stable and unstable equilibrium.

Qn 10: Number of attempts: 95; Mean mark: 8.3; std dev 5.7
A number of candidates produced excellent answers to this question, but a much greater number struggled to apply very familiar electromagnetic laws in a slightly different context.

5. September Re-sits

Two candidates failed and four passed.

CP3 report 2025

June 2025 paper: No issues were reported with this paper. Whilst many candidates showed solid mathematical problem solving skills, a number of marks were lost across the full set of scripts for insufficient clarity of notation (e.g. ambiguities from introduction of symbols/variables without defining them), or in the explanation of methods.

Q1. *Raw mean* 4.3/6, *standard deviation* 1.2.
Real and imaginary parts of complex numbers. Common places for losing marks were calculation error, or clarity on the multiple branches of solutions for non-integer powers and logarithms.

Q2. *Raw mean* 3.8/6, *standard deviation* 1.7.
Derivation of the triangle inequality for real vectors. Common causes of losing marks on (a) were errors in evaluating $|\mathbf{a} + \mathbf{b}|$ in terms of $\mathbf{a}$ and $\mathbf{b}$, unclear reasoning, or logical inconsistencies. Solutions using a dot product tended to be shorter than those that expanded out all individual components of vectors.

Q3. *Raw mean* 4.7/5, *standard deviation* 0.6.
Solutions of linear systems. Done well in most cases.

Q4. *Raw mean* 4.1/7, *standard deviation* 1.7.
Complex variables and curves in the Argand plane. Part (a) was usually done well (with the most efficient solutions using the complex exponential form, rather than expanding out the real and imaginary parts). Common places for losing marks in part (b) were either failing to deduce and sketch the curve as a hyperbola, insufficient clarity on the sketches (i.e. not indicating directions of asymptotes/values of axis intercepts), or errors in applying a rotation to infer the second sketch.

Q5. *Raw mean* 4.2/7, *standard deviation* 1.5.
Properties of vector spaces, applied to sets of Hermitian and unitary matrices. Many solutions dropped marks in (a) on verifying the properties of a vector space. For full marks it was necessary to justify that the set was closed under scalar multiplication and addition, the existence of a zero element and additive inverse, and provide some form of justification that the appropriate properties of associativity, commutativity and distributivity were satisfied for scalar multiplication/vector addition. Full marks were also given for solutions that verified that Hermitian matrices satisfy the necessary conditions to form a subspace, provided that they also justified which vector space this was a subspace of, and noted that a subspace was itself a vector space. There was a spread of performance in (b): some well-justified arguments or counterexamples, but varying progress overall.

Q6. *Raw mean* 6.2/9, *standard deviation* 1.8.
First order differential equations. Many solutions failed to initially spot that (a) was an exact differential, instead rearranging and calculating integrating factors, before realising this simply recovers the initial exact differential. Some care was needed for determining whether the solution passes through the given point, because the limiting behaviour as $x \to 1$ depends on the integration constant chosen. There were a significant number of successful solutions to part (b), by identifying a suitable substitution. Other solutions used an integrating factor to construct an exact differential, which was more longwinded, but in some cases showed good perseverance to recover the final answer.

Q7. 166 *attempts, raw mean* 13.8/20, *standard deviation* 3.7.
Eigenvalues, eigenvectors and geometrical interpretation of a real symmetric matrix. Many candidates correctly noted that a real symmetric matrix has real eigenvalues, but some did not articulate that eigenvectors corresponding to distinct eigenvalues are orthogonal. A discussion of the eigenspaces for

degenerate eigenvalues was only occasionally given. There was often good progress in (b)(i) and (ii). Part (b)(iii) revealed some confusion over the definition of an orthogonal matrix; a number of solutions tried to argue that a matrix made of orthogonal column vectors is orthogonal, rather than requiring orthonormal vectors. Credit was given for solutions using the latter, the relation $R^T R = I$ for an orthogonal matrix R, or its consequences. In (c)(i), a number of solutions didn't use the suggestion to express **b** in terms of the eigenvectors, and resorted to matrix diagonalisation techniques with varying success. The geometrical interpretation in part (c)(ii) lead to a spread in the distribution of marks.

Q8. 116 *attempts, raw mean* 15.0/20*, standard deviation* 2.6.
Finding lengths, volumes and equations of planes using vector manipulations. This was overall done well, with very low scores only usually encountered where the candidates might have run out of time. Common or occasional places for losing marks were calculation errors, incorrectly writing $|\mathbf{a} \times \mathbf{b}| = |\mathbf{a}|\,|\mathbf{b}|$, failing to correctly specify α, β and γ in part (b)(ii), and in clarity of explanation of the solution method (e.g. listing equations without explanation/definition of variables, or without justification of assumptions made).

Q9. 140 *attempts, raw mean* 13.8/20*, standard deviation* 3.6.
Forced-damped harmonic oscillators. After reviewing a sample of scripts, it was decided to reallocate 1 mark from part (a) to part (d), to allow more nuance in crediting candidates for the quality of their explanation in (d). Part (a)(i) was mostly done well, although some solutions forgot to explain the ansatz assumed. In (a) (ii) some candidates calculated the solution but missed the sketch, or didn't label in sufficient detail. Part (b)(i) was mostly done well, but a number of solutions missed the definition of root-mean-square displacement in (b)(ii). In (c), solutions that rewrote $f(t)$ in terms of $\cos 2\omega t$ tended to make more progress. The best solutions to (d) commented on the resonance now arising in case (b) and resulting linear growth of amplitude over time, but justified why there was no resonance in (c).

Q10. 142 *attempts, raw mean* 14.5/20*, standard deviation* 4.1.
Part (a) involved coupled first-order differential equations, and part (b) a second-order differential equation with non-constant coefficients solved by changing variable. A variety of solution methods were pursued in part (a) - matrix methods, mode decoupling, or manipulation into a second order ODE in one variable. In order to obtain full marks the steps in the method needed to be explained clearly, with relevant substitutions identified or explained. The most frequent sticking point on (b) was an error in converting the second derivative using the chain rule, but a significant number of candidates progressed to the final part. Full marks were obtained in (b)(iii) for clearly labelled sketches on the correct domain, and justifying the amplitude and sign of the modes.

September 2025 paper: No issues were reported with this paper. The scripts of most of the candidates demonstrated an improved depth of knowledge of the examined material versus the June examination performance, with some performing substantially better. One candidate scored under 40.

1 CP4 June 2025 report

Total number of candidates: 171
Average mark: 64.3
Top mark: 93
Standard deviation: 15.3
Median: 66
Number passing ($\geq 40\%$): 160
Number failing ($< 40\%$): 11

Q1 (3.4 ± 0.8 out of 4)
Limits of a function of one variable (L'Hopital's rule and/or Taylor series). Straightforward for most students.

Q2 (4.1 ± 1.9 out of 6)
Wave packets, group velocity and dispersion. A significant minority of students struggled to express the wavelengths of the envelope and carrier wave in terms of the given wave numbers.

Q3 (3.1 ± 1.6 out of 5)
Differentials of functions of two variables. A number of students did not realise that they could isolate the requested differentials by taking linear combinations of the starting differentials in part (a); others did not realise that they should equate the coefficients in front of the appropriate differential in part (b).

Q4 (4.7 ± 1.7 out of 7)
Marginal distributions and expectation value. Many students used the wrong limits of integration when calculating the marginal distribution of Y in part (b).

Q5 (4.8 ± 2.0 out of 7)
Surface integral for a conic section. The most common mistake was the neglect of the surface curvature when calculating the area element.

Q6 (3.9 ± 1.8 out of 6)
Line integrals and conservative fields. A small fraction of the students realised that one of the terms could be written as the gradient of a scalar and

quite a few struggled to express this term correctly in Cartesian coordinates.

Q7 (1.9 ± 1.5 out of 5)
Taylor series of a function of two variables and the nature of its stationary points. Many students skipped this question and others seemed to be confused about how to apply the Taylor expansion.

Q8 (13.4 ± 4.2 out of 20; attempted by 161 out of 171)
Jacobian determinant, surface and volume integrals and the divergence theorem applied to a torus. Part (a) required calculation of the Jacobian determinant for a given set of curvilinear (toroidal) coordinates. Most students had no trouble, though a few made mistakes in differentiation or in the subsequent algebraic manipulations for the determinant. Part (b) was a calculation of the surface area and volume of a torus, and most students had no difficulty with this. Part (c) requested students to verify the divergence theorem for a given vector field. Obtaining the volume integral was straightforward, but quite a few students struggled with decomposing the surface integral and calculating the different contributions.

Q9 (13.5 ± 4.0 out of 20; attempted by 144 out of 171)
Transmission and reflection at the interface between connected strings of different mass density. Parts (a-c) were textbook derivations of the wave equation, boundary conditions between connected strings, reflection and transmission coefficients and corresponding powers.

Q10 (13.4 ± 4.8 out of 20; attempted by 162 out of 183)
Stokes' Theorem and line/surface integrals. Most students got only partial points for part (a) because they did not define things like the vector element of surface area or specify that the surface had to be open and simply connected. On the whole students did well in formulating and calculating the necessary integrals to verify Stokes' Theorem for a particular vector field and surface in part (b). Part (c) proved trickier for many: Some did not see that because the bounding curve for the surface was the same as part (b), Stokes' Theorem indicates that it's just the same contour integral (and with the same vector field along the contour). Trying to integrate via projection onto a flat surface was much more involved, though some did manage it.

Q11 (12.6 ± 4.7 out of 20; attempted by 87 out of 183)

Partial differentiation for multi-variable functions, application of the divergence theorem and manipulation of vector quantities. Most students got full marks for parts (a) and (b), though some struggled to properly apply the chain rule and/or see what variables should be held fixed when differentiating in (a). Part (c) should have introduced the constraint $d\rho/dt = 0$, but this was unintentionally omitted in the final version of the exam. Consequently, full marks were given as long as a student correctly wrote $d\rho/dt$ in terms of $\nabla \cdot (\rho \mathbf{u})$, regardless of what other assumptions students may have made in this part. Part (d) asked students to evaluate the time derivative of the integral of ρ over a fixed volume. The students were meant to see that the integral was a function only of t so that the time derivative could be taken inside the integral and evaluated at fixed position. Many did not get this far or did not seem to have an idea of how to approach the problem. Some did it correctly (assuming $d\rho/dt = 0$), while others assumed that $\partial\rho/\partial t = 0$ and incorrectly operated with the full time derivative on the integrand. The difference between these two assumptions was only a difference in the sign of the final answer, and given the omission in part (c), almost full marks were given for a consistent application of either assumption. A handful of students noticed that the vector $\mathbf{u}$ was not actually divergence-free and so the integral to be evaluated was much more involved than intended. These students, as well as those that used the divergence form, were given full marks so long as they set up the integrals correctly.

Report on SO1 2025 Prelims

84 students took the paper. The unscaled mean was 66% with a variance of around 14%.

I now look at each question in turn

Question 1 consisted of 5 parts. Part a) was a textbook explanation which all the students did correctly. Part b) involved either an application of CR conditions or guessing the form – most students did well. Part c) involved finding the residue of a function; hardly any student got the right answer, mostly getting muddled with combining a number of Taylor expansions. Part d) involved finding poles and residues which almost all students did (mostly) correctly. Part e) involved doing a contour integrals. Almost all students were able to pick the correct contour and do the calculation with the residue theorem.

This question was answered by 80 students and the mean mark was 18.3

Question 2 consisted of 5 parts. Part a) was a textbook explanation which all the students did correctly. Part b) involved finding the McLaurin expansion in two different regimes. Almost all students did the first part correctly but had trouble with the second part. Part c) involved finding the poles and branch cuts. Almost all students did this correctly. Part d) involved calculating a contour integral – most students correctly identified the contour and found the correct integral. Part e) was a trigonometric integral – most students were able to convert it into contour integral, very few go exactly the right answer.

This question was answered by 67 students and the mean mark was 15.2

Question 3 consisted of 5 parts. Part a was a textbook explanation which all the students did correctly. Part b) involved a generalization of a problem the students have seen in class; not all students were able to get this right. Part c) involved a conformal transformation which most students understood well. Part d) involved finding the residue of a function which almost all students did well. Part e) involved a contour integral of the function of part d. Most students were able to tackle this question but many were unable to finish it correctly.

This question was answered by 20 students and the mean mark was 15.8.

30th June, 2025

Report, SO02 exam June 2025

Overall:

The results of the exam were as expected, that is to say rather disappointing, with an average of 26.0/50 for 25 Prelims students (and one visiting student). However, as in recent years, these blind statistics are totally misleading, as a substantial number did not prepare at all for the exam and therefore got very low marks, including a few students who clearly never looked up anything on the course (and certainly never read/watched any of the lectures), essentially trying to scavenge a few marks from their general physics and high school knowledge. Many more students likely had only a cursory look at the material (probably reading the lecture notes 2 – 3 times). This view is supported by informal feedback from students and the very large mark dispersion, 10.6/50. Excluding clearly outlying results (on the low side) from the statistics yields a mark distribution that is perhaps somewhat low (it is hard to know where to draw the line) but more standard and as desired.

As the Prelims marks do not count toward the final degree classification, and passing the Prelims-only short options is not a requirement to progress to Part A (and the short options exam is much later than those of the core papers), it is of course hard to fault the students for this approach. Unless the Prelims-only short options count for something (anything really), they are doomed to irrelevance.

Question 1:

Average: 10.4/25

Question 1 was reasonably popular, taken by 56% (14/25) of the students, but it was only marginally successful. Although apparently about the "planets" part of the course, it did not require any specific astro- physics knowledge from the course, being a straightforward application of the Mechanics course material. Most students lost many marks in the quantitative sub-questions, either making unnecessary/unwarranted assumptions or simply not knowing how to proceed, but fared much better in the qualitative sub-questions.

a) The first sub-question was identical to a question from the Mechanics problem set, so it was surprising that very few students calculated the total energy of the system to demonstrate it is negative, as required. More students attempted to show that the velocities of the star and planet are greater than their escape velocities (equally valid but more difficult). Many got lost in the algebra.

b) The second sub-question was a slight generalisation of the same question from the Mechanics problem set, with the addition of the factor β. Not a single student realised that the laboratory frame is no longer the centre-of-mass frame, all attempting to calculate the total energy in the lab frame, which is irrelevant. Many implicitly assumed that the system was still bound (e.g. by assuming that the orbits are still circular), which unsurprisingly (i.e. by contruction) then led to it indeed being bound.

c) – d) The third and fourth sub-questions simply asked to regurgitate some material from the lecture notes, with good success. Suprisingly, some students described the strengths and weaknesses of planet detection methods different from those stated/requested.

Question 2:

Average: 16.5/25

The second question was clearly related to the "stars" part of the course and was by a small margin the second most popular one, taken by 68% (17/25) of the students. Nicely, students performed better than expected, especially in the quantitative sub-questions.

a) – b) The first sub-question was a straightforward application of the key equations of stellar structure given a radial mass volume density profile, and most students got perfects marks. In the second sub-question the students had to combine the results with yet another equation, and repeat the process for two different cases. Not all thought about combining the equations, and many made basic calculus, algebra, and even arithmetic mistakes. Those that did not performed well.

c) – d) The third and fourth sub-questions essentially asked to regurgitate material from the lecture notes. Most did very well, although suprisingly many did not know the PP1 chain of reactions in the Sun, coming up with rather creative answers. Many also did not use the previously derived mass-luminosity relation for the last part of the fourth sub-question.

Question 3:

Average: 12.5/25

The third question was clearly related to the "cosmology" part of the course and was by a small margin the most popular one, taken by 72% (18/25) of the students. Students who had (presumably) looked at similar examples in the lecture notes did very well, the others unsurprisingly did not. Many students also lost many marks due to being unable to properly solve trivial differential equations leading to power-law or exponential behaviours.

a) The first sub-question led to a simple differential equation, but many did not consider the integration constant nor set the associated boundary condition. Some gave the usual age of the Universe rather than the one derived from the problem/universe at hand.

b) The second sub-question again led to a simple differential equation, but many students did not notice the unusual boundary condition required to set the integration constant (which fortunately cancelled out in all following steps). Many students struggled to evaluate the expression given, often setting the clealy time- varying part to a constant, and virtually nobody could estimate the angle required despite an analogous example in the lecture notes.

c) The third sub-question asked to regurgitate qualitative material from the lectures notes, but for un unknown reason many confused the "tenets of the cosmological principle" with the "evidence for the big bang/expanding universe".

S3 Option Paper.

Problem 1 tested the students' understanding of quantum measurements. The students were asked to explain the quantum measurement of a polarization state of the photon and its consistency with classical measurements with macroscopic amplitudes. The students then needed to calculate the polarization state from measurement outcome probabilities in multiple bases. In the final part of the problem, the students were asked to explain how a state can be a statistical mixture of pure states, and, given the measurement statistics of a fully mixed qubit state in multiple bases, identify that state. The students showed good understanding of the measurement postulate, although fewer were able to connect the click probabilities with classical intensities as squared absolute value amplitudes. About one-half of the students were able to calculate the state in the second part; others failed mostly because they forgot that component amplitudes in a superposition state may be complex. The students were less successful in the last part of the problem: most looked for a pure state solution even though a hint about mixed states was given. Mean = 13.3/25.

Problem 2 required students to analyze a rudimentary version of Shor's error correction protocol for a quantum computer. Full description of the protocol in terms of quantum gates was given, and the students were expected to determine the state of the data qubits and, when relevant, ancillary qubits in each step of the protocol. Although the problem was the simplest in terms of calculations required, the students were apparently intimidated by it: only seven students attempted it. Most of these students successfully reached the stage of determining the state of the ancillary qubits and showing that measuring these qubits uniquely identifies the error. Fewer students were able to suggest the operation that recovers the data qubits from the error, apparently forgetting that the ancillary qubits after the measurement should be treated as classical data, not a part of the quantum state. Mean = 16.1/25.

Problem 3 tested the students' ability to handle entangled states and their evolution. They were presented with a common setting in which a C-Phase gate was sandwiched between two Hadamard gates, making up a C-Not gate. They were not given the names of these gates, but their descriptions, and were expected to eventually recognize this setting, with which they are familiar from the class. While the students were almost universally able to handle single-qubit operations, a majority struggled with the task of writing the Hamiltonian and evolution operator for the two-qubit state, with a significant number of candidates even failing to recognize that the corresponding Hilbert space is four-dimensional. Mean = 11.3/25.

General Philosophy (for CSP, MP, & PP)

The distribution of marks on this section was in line with previous years, with a mean mark in the mid-60s, and marks ranging from the high 40s to low 80s on individual questions. Below can be found commentary on individual questions.

1. *Should the problem of philosophical scepticism have any impact on our day-to-day lives?*

   This was a popular question, especially amongst PP candidates. Weak answers simply 'dumped' surveys of e.g. Nozick, with little sensitivity to the question. Better answers leveraged e.g. the upshot of the sensitivity analysis of knowledge to argue that everyday knowledge can be retained despite the problem of philosophical scepticism, and as such we shouldn't be troubled by the latter. The best answers discussed e.g. Quine on the naturalisation of epistemology.

   Average mark for the question: 64

2. *Let 'counter-induction' be the thesis that the future will not resemble the past. Assess this argument: "Counter-induction has never worked in the past. So, it will work in the future."*

   This question was generally answered well; candidates discussed the differences between induction and counter-induction, issues of rule vs premise circularity, and probed whether there is any sense in which induction is better justified than counter-induction.

   Average mark for question: 68

3. *"Substance dualism fails, because it cannot explain how any particular mind comes to be paired with any particular body." Discuss.*

   This was a fairly standard question, but there were many weak answers which 'dumped' problems for substance dualism, without sufficient focus on the pairing problem in particular (which was the focus of the question). Candidates would do well to remember that marks can't be awarded for general (but irrelevant) knowledge; essay answers must in fact answer the question.

   Average mark for question: 62

4. *For subject S to know a proposition P, must there be some causal connection between S and the truth of P?*

   This was a popular question, especially with CSP candidates. Again, it was fairly standard; good answers discussed what exactly a 'causal connection' amounts to, and whether this is sufficient or necessary for a subject to know a proposition. In doing so, good answers also discussed apparent counterexamples to the causal connection claim, e.g. the possibility of knowledge of mathematics, etc.

   Average mark for question: 64

5. *Can perception provide knowledge of the external world if I can't be certain that my perceptions are veridical?*

This question was answered quite reasonably; almost all candidates answered that certainty about the veridicality of one's perceptions isn't necessary for knowledge by perception; better answers used particular analyses of knowledge to undergird this (e.g., externalist analyses of knowledge).

Average mark for question: 66

6. *Is being the same person over time simply a matter of being the same animal over time?*

This question was generally answered badly. There was (as with question (3)) insufficient focus on the question as asked; rather, candidates 'dumped' tutorial content on the memory criterion for personal identity, etc. Candidates would have done better if their answered has tracked more closely and exclusively animalism about personal identity and its discontents.

Average mark for question: 61

7. *Suppose that we inhabit a multiverse in which everything which can happen does happen. Are the prospects for a compelling notion of free will any better in such a scenario?*

There was quite a range of answers to this question. On the positive side, the slightly non-standard nature of this question provoked independence of thought, and several candidates wrote very good and clear answers on how the existence of a multiverse doesn't substantially help with the problem of free will. On the other hand, weaker answered appeared confused, meandering, and unclear. One general comment on this question is that almost all candidates could have been clear about what they actually take a 'multiverse' to be.

Average mark for question: 66

8. *Is the existence of evil caused by humans compatible with the existence of God?*

This question was generally answered well: candidates homed in on the logical problem of evil, and the best discussed Plantinga on transworld depravity etc. with an impressive level of sophistication.

Average mark for question: 67

The Leibniz-Clarke Correspondence (for PP)

This part was generally answered well, although only three questions (on Descartes, Newton, and the PII) were answered by significant numbers of candidates. This reflects trends in previous years, so in future years it might be worth thinking about whether it is necessary/optimal to include questions on e.g. parity violation (which nobody answered). Below can be found commentary on individual questions.

9. *Explain the principal weaknesses of Descartes' account of motion. Which, if any, of these would remain if one were to ignore Descartes' principle of inertia (i.e., his first two laws of nature)?*

   This was the second most popular question. Almost all answers gave competent presentations of Newton's criticisms of Descartes. The better answers were able to explain clearly which of those criticisms would survive if the principle of inertia were to be ignored (worse answers did not dedicate sufficient time to that part of the question).

   Average mark for question: 68

10. *How is the distinction between substantivalism and relationalism best drawn?*

    Only one candidate attempted this question. Unfortunately, the answer was mostly 'dumped' content on Leibniz' views, as such, the question did not receive a good mark.

    Average mark for question: omitted for small sample size

11. *'The globes thought experiment establishes that if the rod linking the globes can have non-zero tension, then Newton's laws of motion require a standard of absolute rotation. But there are no good reasons to think that the rod linking the globes can have non-zero tension.' Would this be a good response to Newton's arguments for absolute motion?*

    This was a very popular question, answered by almost all candidates. Good answers probed the purpose of the globes thought experiment (is it in fact an argument *for* absolute motion?), and also whether the Machian response in the question is begging the question, etc.

    Average mark for question: 65

12. *The laws of particle physics violate parity (i.e., spatial reflection) symmetry. What are the consequences of this, if any, for the ontology of space and time?*

    No candidates answered this question, possibly because it was not covered in the lectures.

13. *Suppose the speedometer of one's car matches the absolute velocity of the car. Would it be correct to say that one is measuring the car's absolute velocity in that case?*

    There was one answer to this question, which was of reasonable but not exceptional quality. Good answers could have considered e.g. whether bona fide measurements

require robust co-variation between what's being measured and the measuring device (which is not the case here).

Average mark for question: omitted for small sample size

14. *What is Leibniz' Principle of Identity of Indiscernibles as it appears in the Leibniz-Clarke Correspondence? What is Leibniz' strongest argument for this, and is the argument successful?*

This was also a relatively popular question. Good answers were focussed on the PII as presented by Leibniz *in the Correspondence*, and distinguished between PII as applied to object vs as applied to worlds. Worse answers elided or omitted some of these versions of the PII, or were otherwise less clear on the specifics of Leibniz' arguments for the PII in the Correspondence. Overall, answers to this question were on the weaker end.

Average mark for question: 61

Philosophical Topics in Logic and Probability Theory/EDL

Combined Report for Mathematics & Philosophy/Physics & Philosophy/ Computer Science & Philosophy Prelims

There were 42 entries for this paper: 11 Computer Science and Philosophy candidates, 14 Mathematics and Philosophy ones, and 17 Physics and Philosophy ones. No students failed. Overall, the standard was high. All candidates answered two questions from the Introduction to Logic section. There was an unfortunate typo in part (f) of Question 1, and two other minor typos that were relatively insignificant. Although the examiner was present in the exam room on the day, they were not able to correct the typo and notify students, as this is no longer allowed. 1(f) was therefore marked extremely generously.

In addition to these 42, one Physics and Philosophy student resat the Elements of Deductive Logic (EDL) paper and passed.

The averages per school per question on the PTLP paper were as tabulated below. The average overall mark on the paper for all three schools combined was **67.05**.

		Number of takers	CS&P average	M&P average	P&P average	Combined average
Section A – Introduction to Logic	Question 1	28	19	18.22	20.31	19.36
	Question 2	34	15.1	17.5	15.25	16.1
	Question 3	22	19.5	17.86	15.33	17.3
Section B – Philosophical Topics in Logic	Question 4	15	20.5	16.17	13.13	15.53
	Question 5	9	20	17.5	18.17	18.22
	Question 6	4	15	13	1	10.5
Section C – Philosophical Topics in Probability Theory	Question 7	28	16.8	19.89	10.78	15.86
	Question 8	23	16.87	18.57	15.56	16.91
	Question 9	5	N/A	15	15	15

Introduction to Logic – Question 1
This question was very well done, especially given the very high marks awarded for part (f).

Introduction to Logic – Question 2
Generally well answered. Many candidates seemed unwilling to go into detail in (a) and in their answers to (c) seemed unaware of the problems caused by plurals and propositional quantification.

Introduction to Logic – Question 3
Generally well answered. Many students didn't seem to appreciate that, unlike quotation marks, there is no distinction between a left and a right asterisk. In part (b), aesthetic considerations were not what examiners were looking for.

Philosophical Topics in Logic – Question 4
Generally well answered, with (c)(ii) giving candidates the most trouble. Some candidates confused the quantifier in (d) with 'there exist at least two'.

Philosophical Topics in Logic – Question 5
Generally well answered. Marks were deducted for not paying close attention to Skolem's text, as the question requested.

Philosophical Topics in Logic – Question 6
A very difficult question with few takers. The exam setters felt it was reasonable to set one hard question given that the others were generally easy, but this was arguably too hard a question.

Philosophical Topics in Probability Theory – Question 7
Generally well answered. A surprising number of candidates did not really know what a σ-algebra was and hence fell down on (b). Some of the calculations in part (d) were long and not many candidates completed them.

Philosophical Topics in Probability Theory – Question 8
A gift of a question that was well answered. Candidates tended to focus on the binary case in (c) even though the question explicitly asked for the more general finite case.

Philosophical Topics in Probability Theory – Question 9
A relatively straightforward question with few takers.

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