

## Candidates' Performance

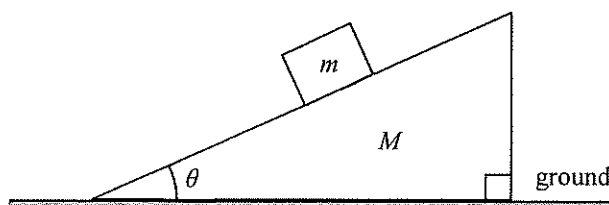
### Paper 1

Paper 1 consists of two sections: multiple-choice questions in Section A and conventional questions in Section B. All questions in both sections are compulsory.

#### Section A (multiple-choice questions)

Section A consisted of 33 multiple-choice questions and the mean score was 19. Items where candidates' performance was typically weaker will be presented below with mean percentage statistics.

6.

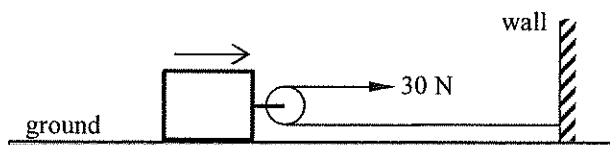


A block of mass  $m$  is placed on a wedge of mass  $M$  as shown. The system remains at rest. What is the normal force exerted on the wedge by the ground ?

- |     |                       |       |
|-----|-----------------------|-------|
| A.  | $Mg$                  | (6%)  |
| *B. | $(M + m)g$            | (47%) |
| C.  | $Mg + mg \cos \theta$ | (39%) |
| D.  | $Mg + mg \tan \theta$ | (8%)  |

Nearly 40% of the candidates answered this question by resolving the force acting on  $M$  by  $m$  and wrongly chose option C.

10.

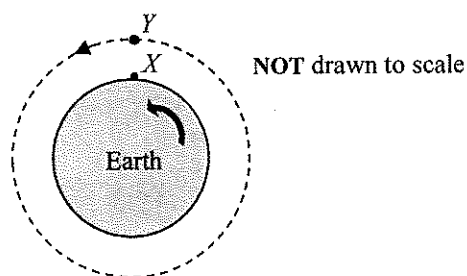


On a horizontal ground there is a block attached with a smooth light pulley as shown. A light and inextensible horizontal string, with one end fixed to a wall, passes the pulley. A man exerts a horizontal force of 30 N at the other end of the string and pulls a distance of 4 m. Find the work done by the man if the ground exerts a frictional force of 10 N on the block.

- |     |                 |       |
|-----|-----------------|-------|
| A.  | $20 \text{ J}$  | (5%)  |
| B.  | $80 \text{ J}$  | (56%) |
| C.  | $100 \text{ J}$ | (7%)  |
| *D. | $120 \text{ J}$ | (32%) |

Candidates choosing option B did not realise that the work done by the man was not equal to the kinetic energy gained by the block in this case.

14. In the figure,  $X$  is an object resting on the Earth's equator.  $Y$  is a geostationary satellite moving in a circular orbit above the equator such that it always appears stationary to an observer on Earth.



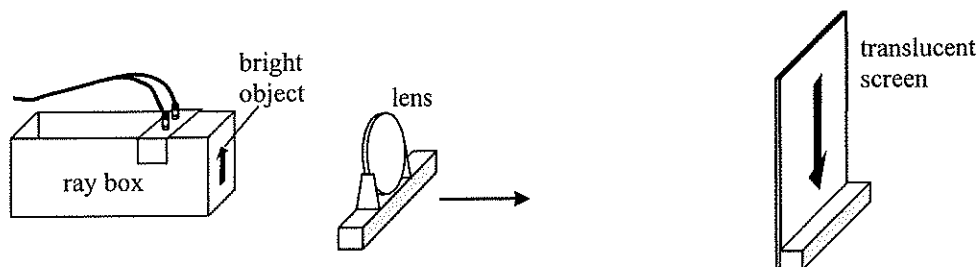
Which descriptions about the motion of  $X$  and  $Y$  are correct?

- (1) The motion of  $X$  and  $Y$  takes the same period.  
 (2)  $X$  is moving with a slower speed.  
 (3)  $X$  has a greater acceleration.

- \*A. (1) and (2) only (52%)  
 B. (1) and (3) only (16%)  
 C. (2) and (3) only (9%)  
 D. (1), (2) and (3) (23%)

Nearly half of the candidates chose an answer that included statement (3), which was incorrect. Candidates may have mistakenly thought that objects nearer to the Earth's surface experience a larger acceleration due to gravity without taking into account their motions.

21. In the set-up below, the separation between the bright object and the translucent screen is fixed. A lens is moved from the object towards the screen as shown.



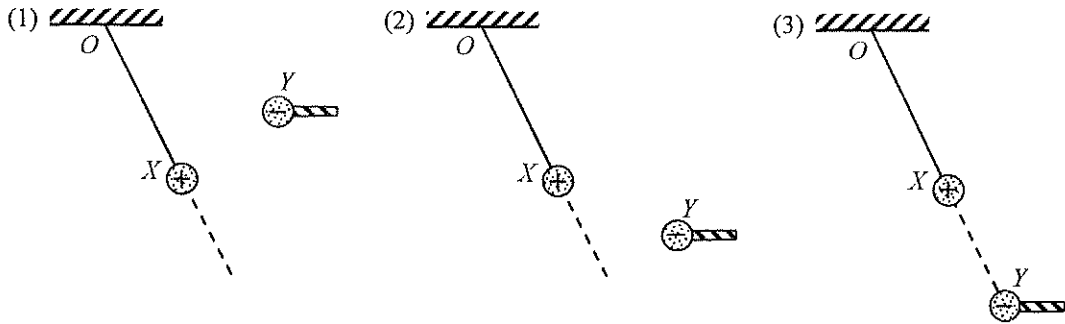
The first sharp image formed is inverted as shown and its length is 9 cm. When the lens is moved further towards the screen, a second sharp image of length 1 cm is observed. Which of the following statements is/are correct?

- (1) The second image is erect.  
 (2) The length of the object is 3 cm.  
 (3) There are at most two positions of the lens that can give a sharp image on the screen when the lens is moved.

- A. (1) only (17%)  
 B. (2) only (25%)  
 \*C. (2) and (3) only (44%)  
 D. (1), (2) and (3) (14%)

Candidates choosing options A and B were likely not familiar with the conjugate nature of the object and image positions derived from the reversibility of light.

23. A positively charged sphere  $X$  of mass  $m$  is suspended from a fixed point  $O$  by a nylon thread. Another negatively charged sphere  $Y$  at the end of an insulating rod is held in various positions as shown.  $O$ ,  $X$  and  $Y$  are in the same vertical plane.

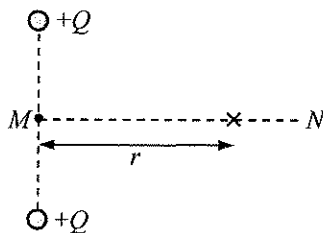


In which situation(s) could  $X$  be kept at rest as shown ?

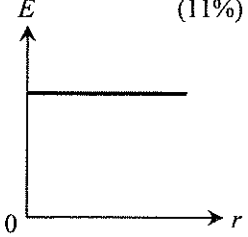
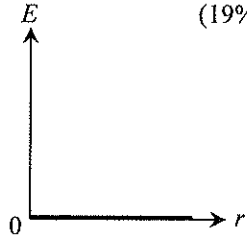
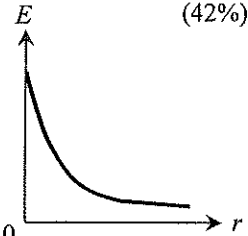
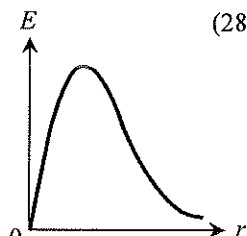
- |     |                  |       |
|-----|------------------|-------|
| A.  | (1) only         | (14%) |
| B.  | (3) only         | (45%) |
| *C. | (1) and (2) only | (24%) |
| D.  | (2) and (3) only | (17%) |

Less than one quarter of the candidates answered this item correctly suggesting that most of them did not fully understand the conditions for coplanar forces to achieve equilibrium.

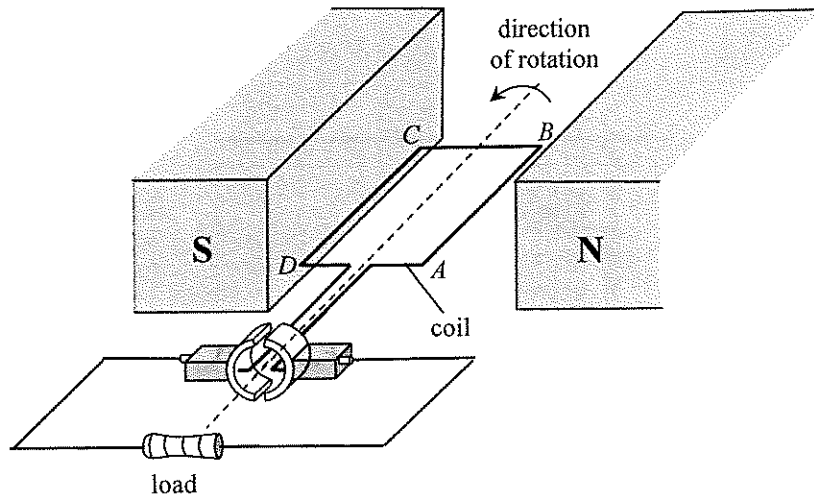
24.



Two positive point charges  $+Q$  are fixed as shown above.  $MN$  is the perpendicular bisector of the line joining the charges. Which graph correctly shows the variation of the electric field strength  $E$  on line  $MN$  with distance  $r$  from  $M$  ?

- |    |   |       |     |  |       |
|----|---|-------|-----|--|-------|
| A. |  | (11%) | B.  |  | (19%) |
| C. |  | (42%) | *D. |  | (28%) |

Candidates choosing option C might have overlooked the fact that electric field is a vector quantity and that the field strength was zero mid-way between the two positive charges.



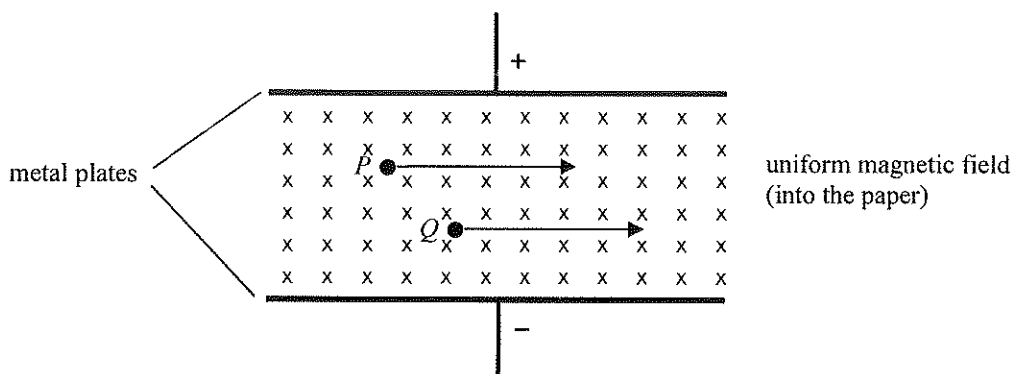
The figure shows the structure of a simple generator. Which of the following statements is/are correct ?

- (1) The magnetic force acting on side  $AB$  of the coil is upward at the instant shown.
- (2) The commutator would reverse the direction of current in the coil whenever the coil passes its vertical position.
- (3) The current flowing through the load is an unsteady d.c.

- |     |                  |       |
|-----|------------------|-------|
| A.  | (1) only         | (24%) |
| B.  | (2) only         | (29%) |
| *C. | (3) only         | (26%) |
| D.  | (1) and (3) only | (21%) |

Over 40% of the candidates indicated that statement (1) was correct. In fact, from an energy point of view, the direction of the magnetic force acting on side  $AB$  should always be opposing the external driving force applied to the generator.

29. Charged particles  $P$  and  $Q$  are moving in a region with mutually perpendicular uniform electric and magnetic fields as shown.



If both particles are not deflected by the fields, which of the following statements **must be** correct? Neglect the effects of gravity.

- (1) They are positively charged.
- (2) They are moving with the same velocity.
- (3) They have the same charge to mass ratio.

- A. (1) only (17%)
- \*B. (2) only (34%)
- C. (1) and (3) only (14%)
- D. (2) and (3) only (35%)

For a total of 30% of the candidates choosing options A or C, these candidates thought that in such a velocity selector, both particles must carry the same kind of charges.

30. Arrange the following in ascending order of power delivered when each of them is connected to the same resistor.

- (1) a 100 Hz sinusoidal a.c. of peak voltage 2 V
- (2) a 50 Hz sinusoidal a.c. of r.m.s. voltage 2 V
- (3) a steady d.c. of voltage 1.5 V

- \*A. (1) (3) (2) (45%)
- B. (2) (3) (1) (18%)
- C. (1) (2) (3) (18%)
- D. (2) (1) (3) (19%)

Less than half of the candidates answered this item correctly which indicates that most of them did not fully understand the relationship between peak and r.m.s. values.

Section B (conventional questions)

Question Number	Performance in General
1	<p>This question examined candidates' knowledge and understanding of heat transfer. The performance was fair. Most candidates knew the meaning of 'fair test' in answering (a). In (b), although candidates mentioned that the rate of energy loss decreased with time, not many were able to explicitly point out that it was due to the decrease in temperature difference. Part (c)(i) was well answered. In (c)(ii), quite a number of the candidates did not know that a shiny surface is a good reflector/poor radiator of thermal energy. Weaker candidates gave wrong explanations in terms of conduction, for example, aluminium is a good thermal conductor. Part (d) was well answered.</p>
2	<p>Candidates' performance was satisfactory. In (a)(i)(I), some candidates calculated the number of moles <math>n</math> only or wrongly took it as the number of molecules <math>N</math>. A few gave a numerical value of <math>n</math> ten times smaller or bigger as the answer. In (a)(i)(II), some candidates mistook <math>N</math> found in (a)(i)(I) as <math>N_A</math> in finding the average kinetic energy <math>E_K</math>. Some wrongly calculated the total kinetic energy of the molecules or divided <math>E_K</math> by the number of moles to get the average kinetic energy. In (a)(ii)(I), some candidates did not demonstrate they understood that <math>E_K</math> remained the same if temperature <math>T</math> was constant while others indicated that <math>N</math> was inversely proportional to <math>m</math> and <math>E_K</math> was proportional to <math>m</math>, probably by referring literally to the equation <math>pV = \frac{1}{3} Nmc^2</math>.</p> <p>Candidates performed well in (a)(ii)(II) except for some who mistook the given root-mean-square speed <math>600 \text{ m s}^{-1}</math> as mean-square speed. Part (b) was poorly answered. Most candidates tried to explain the slow diffusion process using difference in pressure, density, concentration or mass instead of via the microscopic view of gas. Some misinterpreted the question and explained why gas <math>C</math> diffused upward.</p>
3	<p>This question tested candidates' knowledge and understanding of force and motion in the context of a quadcopter. The overall performance was fair. In (a), some candidates failed to state clearly the two balancing forces acting on the hovering quadcopter. A few wrongly thought that the thrust acting on the quadcopter came from the ground's reaction due to the air streams. Answers from weaker candidates suggested they thought that the thrust was greater than the quadcopter's weight. Part (b) was poorly answered. Some candidates had difficulties in handling the equation <math>\text{mass} = \text{density} \times \text{volume}</math> and a few got mass of the quadcopter and mass of air streams mixed up. Candidates did well in (c). Some failed to label correctly the upward thrust acting on the quadcopter or wrongly included a centripetal force in the free-body diagram (which in fact would come from the thrust's horizontal component). A few did not realise that the speed of air streams in (c) was different from that in (b).</p>
4	<p>The overall performance was satisfactory. Most candidates were able to find the gymnast's kinetic energy in (a) although a few gave a wrong unit 'N' for energy. In (b)(i), not many got full marks in describing the conversion of mechanical energy of the gymnast to the elastic potential energy of the trampoline. Part (b)(ii) was poorly answered. Not many were able to employ the principle of energy conservation and work done on the trampoline to estimate the average force exerted by the gymnast. Some failed to obtain the correct answer as they omitted the further loss in gravitational potential energy of the gymnast after the contact was made.</p>
5	<p>This question tested candidates' knowledge and understanding of geometrical optics. Candidates' performance was good. In (a)(i), most were able to draw the refracted rays and obtained the image of the distant object. Weaker candidates wrongly thought that ray <math>q</math> came from the foot of the object. In (a)(ii), many candidates knew that a real image is one that can be captured by a screen. Candidates in general knew how to use side ratios of similar triangles to tackle (b). However, quite a number of them were not careful in obtaining the size and position of the image from the ray diagram as well as manipulating the conversion according to the scales.</p>

6	Candidates' performance was fair. In (a), most candidates knew the meaning of 'coherent', however, some failed to state it concisely. Parts (b)(i)(ii) were well answered. In (b)(i), candidates understood that as a result of interference, alternate maximum and minimum of CRO trace were observed. Some did not get full marks as the correspondence between maximum/minimum and constructive/destructive interference was not explicitly stated. Some mistook the path difference in (c) to be $0.5\lambda$ , $\lambda$ or $2\lambda$ rather than $1.5\lambda$ . In (d), only the most able candidates knew how separation $AB$ and the number of maxima were related. Just over half of the candidates answered (e) correctly.
7	Candidates' performance was unsatisfactory. In (a)(i), quite a number of them wrongly stated the polarity of magnets as positive/negative. Part (a)(ii) was well answered. In (a)(iii), less than half of the candidates knew why the magnets should not be in contact with the iron filings. Many were not familiar with the experiment in (b)(i) despite the magnetic field pattern being a typical one. Very few candidates obtained high marks. In some answers, the needle of the compass drawn on a field line did not align with the field direction and/or with adjacent compasses. A few candidates forgot to describe how to obtain several field lines. However, about one-third of them were able to suggest an advantage of the plotting-compass method in (b)(ii).
8	Candidates performance was fair. Most were able to comprehend the circuit in (a) for finding the I-V characteristics of the light bulb. Many candidates correctly calculated the bulb's rated resistance in (b)(i). In (b)(ii), most knew that the bulb's resistance increased with the applied voltage but few pointed out that there was an increase in current/power. Candidates did poorly in (c). Many did not realise that in the circuit concerned the bulb was not working at its rated values. Thus even for those who correctly drew the required straight line on the I-V characteristics graph, not many were able to utilize the pair of current and voltage readings to find the power in (c)(ii).
9	This question tested candidates' knowledge and understanding of electromagnetic induction in the context of a metal loop entering a magnetic field. The performance of candidates was unsatisfactory. Most were able to indicate the direction of the induced current in (a). A few wrongly drew currents flowing inside or around the magnetic field. In (b), quite a number of the candidates mistook that the induced e.m.f. ( $\mathcal{E} = Blv$ ) only applied to the wire cutting the magnetic field and not the loop (i.e. the complete circuit). A few wrongly equated magnetic force on current-carrying wire with magnetic and/or electric forces on moving charges. Weaker candidates considered 'induced e.m.f.' ( $Blv$ ) to be the 'magnetic force' exerted on a current-carrying wire. In (c)(i), candidates often mistook the $IR$ drop within the wire $YZ$ as the potential difference (p.d.) across it. Some considered the induced e.m.f. or one-quarter of it to be the p.d. across $YZ$ . (c)(ii) revealed that candidates did not have a clear understanding of the relationship between induced e.m.f., p.d. and $IR$ drop across a resistor.
10	This question tested candidates' knowledge and understanding of nuclear fission and fusion. The performance of candidates was far from satisfactory. In (a), most were able to calculate the mass defect correctly. Quite a number of them mistook this mass defect for two deuterium nuclides as the maximum energy produced by one mole of hydrogen/deuterium nuclides. In their calculations, some did not realise that two deuterium nuclides were required for each reaction. A few weaker candidates mistook the mass of a deuterium nuclide or the total mass of helium and neutron as the energy produced. About one-third of the candidates correctly gave an alternate fusion reaction in (b). Many candidates employed general terms in (c) to explain the advantages of fusion over fission: e.g. more stable/safe, less harmful/pollution, higher efficiency, cleaner, etc., without further elaboration. Their answers also revealed a misconception that the energy released by one fusion reaction was greater than that released by one fission reaction.

## Paper 2

Paper 2 consisted of four sections. Each section contained eight multiple-choice questions and one structured question which carried 10 marks. Section A contained questions on 'Astronomy and Space Science', Section B on the 'Atomic World', Section C on 'Energy and Use of Energy' and Section D on 'Medical Physics'. Candidates were required to attempt all questions in two of the four sections.

Question	Popularity (%)	Performance in General
1	18	Part (a) was well answered. In (b)(i), some candidates made mistakes in substituting the masses and/or distances into the equation they set up to find the required distance for $N$ . Not many were able to apply the principle of energy conservation and change in gravitational potential energy to answer (b)(ii). About one-fourth of the candidates realised that the 'stretching' of wavelengths in (c)(i) exhibited the phenomenon of redshift. Parts (c)(ii)(iii) were well answered. In (c)(ii), some had difficulties in handling the conversion of MHz and consequently gave numerical answers ten times smaller or larger.
2	66	In (a)(i), most candidates knew that the range of kinetic energy does not change with intensity but not many were able to give a complete explanation. Many just mentioned what the intensity would affect (e.g. number of photons) but did not explicitly point out the relevant quantities of photons that remained unaltered. In (a)(ii), a considerable number of candidates wrongly divided the photon energy by $1.6 \times 10^{-19}$ to work out the number of photons. In (b), some candidates mixed up stopping potential $V_s$ with maximum kinetic energy $KE_{\max}$ and presented $V_s$ in eV or in J. In (c), again the conversion between joule and eV was often incorrect, with $1.6 \times 10^{-19}$ found at a wrong place in their expressions. Weaker candidates sometimes substituted wavelength as a frequency.
3	85	Part (a)(i) was well answered except for a few candidates who got input and output powers mixed up. In (a)(ii), some candidates overlooked the stated generation capacity limit and casually rounded up the 26.3 solar panels found to 27. One-third of them knew the function of the inverter in (b)(i). Candidates performed well in (b)(ii). For the explanation in (b)(iii), many stated factors which had already been given indirectly in the question e.g. weather conditions or efficiency of solar panels. Candidates did well in the estimation in (b)(iv). Many answers regarding the comparison between solar and wind power systems were not based on domestic generation as required in (c).
4	31	Most candidates did well in (a)(i) although a few made mistakes in the unit of acoustic impedance. Many were able to answer (a)(ii) by using $\frac{\sin \theta_{\text{air}}}{\sin \theta_{\text{skin}}} = \frac{\text{speed of sound in air}}{\text{speed of sound in skin}}$ . However, some wrongly substituted the speed(s) or employed the formula involving intensity reflection coefficients. (a)(iii) was poorly answered. Not many realised that the bending of the ultrasound beam implied from (a)(ii) would lead to distortions in the ultrasound image in terms of location as well as brightness. Significant bending occurred even for a small deviation from the perpendicular position (the ultrasound speed in skin is almost five times that in air), thus echoes would no longer return to the transducer along the same straight path as one might have assumed. In (b)(i), most gave partially correct answers about the nature of radiations used. A few wrongly thought that a beta source rather than a gamma source was injected into the body. Many failed to state an X-ray tube as the source of X-rays. More able candidates referred to the abnormal uptake of radioactive source by the target organ, which indicated a functional problem (e.g. hot spots in the case of bone scan). (b)(ii) was well answered.