Candidates' Performance

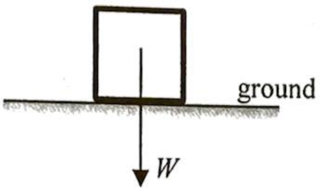
Paper 1

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.

4. A block of weight W is at rest on a horizontal ground as shown.



The force acting on the block by the ground is R. Which of the following statements is/are correct ?

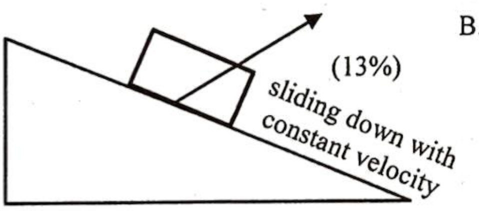
(1) R and W are opposite in direction.
(2) R and W are equal in magnitude.
(3) R and W is an action-and-reaction pair.

A.	(1) only	(3%)
*B.	(1) and (2) only	(43%)
C.	(2) and (3) only	(1%)
D.	(1), (2) and (3)	(53%)

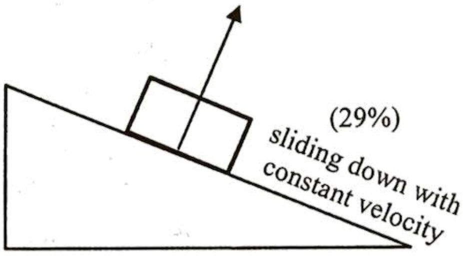
Over half of the candidates wrongly thought that R and W is an action-and-reaction pair.

5. A block is sliding down a rough incline with constant velocity as shown. Which arrow indicates the direction of **the resultant force acting on the block by the incline** ? Neglect air resistance.

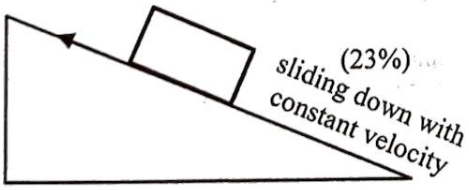
A.



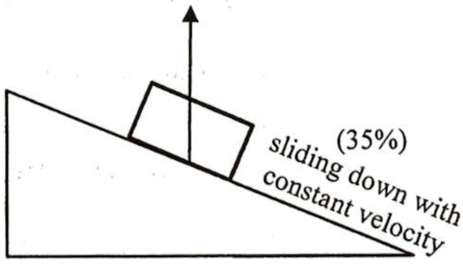
B.



C.



*D.



Just over one-third of the candidates realised that the resultant force from the incline acting on the block in uniform motion should balance the block's own weight.

8. A stationary uranium nucleus ${}^{238}_{92}\mathrm{U}$ decays to give a thorium nucleus ${}^{234}_{90}\mathrm{Th}$ and an α particle ${}^{4}_{2}\mathrm{He}$.

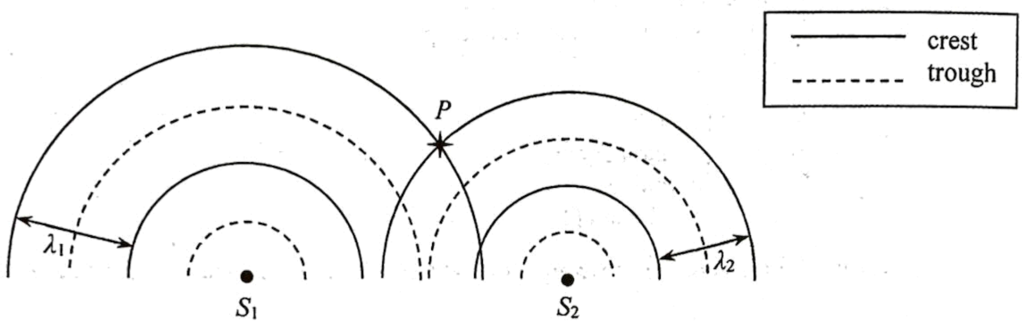
$$ {}^{238}_{92}\mathrm{U} \longrightarrow {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He} $$

Which of the following correctly describes the situation about the ${}^{234}_{90}\mathrm{Th}$ nucleus and the α particle just after the decay ?

	magnitude of momentum p	kinetic energy KE	
*A.	$p(\mathrm{Th}) = p(\alpha)$	$\mathrm{KE(Th)} < \mathrm{KE}(\alpha)$	(44%)
B.	$p(\mathrm{Th}) > p(\alpha)$	$\mathrm{KE(Th)} > \mathrm{KE}(\alpha)$	(18%)
C.	$p(\mathrm{Th}) = p(\alpha)$	$\mathrm{KE(Th)} > \mathrm{KE}(\alpha)$	(29%)
D.	$p(\mathrm{Th}) = p(\alpha)$	$\mathrm{KE(Th)} = \mathrm{KE}(\alpha)$	(9%)

While over 80% of the candidates indicated knowledge that the momentum of the two decay products is equal in magnitude, just over 40% of them knew that most of the kinetic energy goes to the lighter α-particle.

14. In a ripple tank, circular water waves of wavelengths λ_1 and λ_2 ($\lambda_1 > \lambda_2$) are produced by two vibrators S_1 and S_2 respectively. The figure represents the two circular waves propagating on the water surface at a certain moment.



Which of the following statements is correct ?

A. The particle at P is always at crest position. (10%)
B. At P, the two waves always reinforce to give a larger amplitude. (29%)
C. The principle of superposition cannot be applied at P as $\lambda_1 \neq \lambda_2$. (14%)
*D. The principle of superposition can be applied at P but the two waves do not always reinforce at that location. (47%)

About 30% of the candidates wrongly held that two waves of different frequencies would always reinforce to give a larger amplitude at a certain location.

20. Submarines employ ultrasound instead of microwaves to detect obstacles in the sea. This is because

A. wavelengths of ultrasound are shorter than those of microwaves. (17%)
B. ultrasound travels faster than microwaves in the sea. (24%)
*C. microwaves are easily absorbed by sea water. (33%)
D. microwaves diffract too much in the sea. (26%)

Just about one-third of the candidates knew the reason why microwaves are not used for detection in the sea.

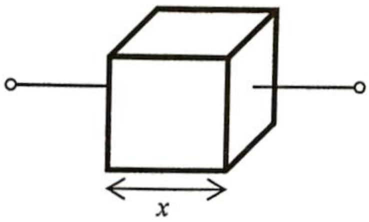
22. When a point charge $+Q$ is placed at X as shown, the strength of the electric field at Y is E_0.

If W and Z are each placed with a point charge of $+Q$, what will be the electric field strength at Y ?
Note: $\sin 45° = \cos 45° = \frac{\sqrt{2}}{2}$

*A.	$\frac{\sqrt{2}}{2} E_0$	(28%)
B.	E_0	(23%)
C.	$\sqrt{2}\, E_0$	(38%)
D.	$2\, E_0$	(11%)

Less than 30% of the candidates were able to compute the vector sum of the electric fields created by the point charges.

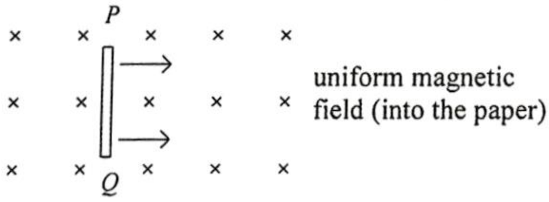
24. The figure shows a metallic cube of side length x. How is its resistance R between any two opposite faces related to x ?



*A.	$R \propto \frac{1}{x}$	(45%)
B.	$R \propto x$	(15%)
C.	$R \propto x^2$	(15%)
D.	$R \propto \frac{1}{x^2}$	(25%)

Candidates choosing option D may only have considered the cross-section of the cube and overlooked the contribution of its length.

26. When a copper rod PQ moves with a constant velocity across a uniform magnetic field as shown, an e.m.f. is induced across the rod.



Which of the following statements is/are correct ?

(1) The magnitude of the induced e.m.f. depends on the length of the rod.
(2) Rod PQ acts like a cell providing an e.m.f. with P being its positive terminal.
(3) There is a force acting on the rod to oppose its motion.

A.	(1) only	(22%)
B.	(3) only	(21%)
*C.	(1) and (2) only	(35%)
D.	(2) and (3) only	(22%)

Over 40% of the candidates wrongly held that statement (3) is correct. They did not notice that no induced current flows in the rod and therefore no opposing force results.

33. Which of the following may contain sources of ionizing radiations ?

(1) sea water
(2) a rock sample
(3) human body

A.	(1) only	(8%)
B.	(2) only	(32%)
C.	(2) and (3) only	(12%)
*D.	(1), (2) and (3)	(48%)

Less than half of the candidates answered correctly. It seems that they were not familiar with the various natural sources of radiations in the environment.

Section B (conventional questions)

Question Number	Performance in General
1	This question examined candidates' knowledge and understanding of heat transfer. Candidates' performance was satisfactory. Most candidates managed to obtain the correct numerical answers in (a) and (b). However, some failed to present the answers with correct units. Part (c) was well answered. In (d), weaker candidates wrongly held that a good conductor such as copper absorbed more thermal energy. Perhaps they got heat capacity and conduction mixed up.
2	Candidates' performance was satisfactory. In (a), quite a number of the candidates did not realise that the sound travelled twice the water depth within the time interval. Most were able to apply the ideal gas equation to answer (b)(i) although a few candidates forgot to add 273 in converting the temperature in degrees Celsius. A lot of the candidates were competent in using kinetic theory to explain the pressure drop in (b)(ii). Candidates employed different approaches, including mole ratio or pressure ratio, in answering (c). Quite a number of them did not realise that the pressure of compressed gas needed to be greater than the pressure outside, i.e. 4.0 atm at the seabed.
3	This question tested candidates' knowledge and understanding of projectile motion in the context of a volleyball game. The overall performance was good. In (a)(i), most candidates knew that the work done on the ball became its kinetic energy. A few misinterpreted the situation and also considered the ball's gravitational potential energy in the calculation. In (a)(ii), nearly half of the candidates computed the horizontal and vertical components of the velocity separately rather than simply using the method of conservation of mechanical energy. Weaker ones held that *B* was the highest point of the trajectory in (b)(i). In (c), most knew that the suggested way would result in a shorter time of flight. However, some failed to point out explicitly that this was due to a larger horizontal component of the velocity. Part (d) was well answered, although some candidates wrongly stated that a concrete floor providing larger friction was the reason.
4	Candidates' performance was fair. Although many were able to indicate the forces in the free-body diagrams in (a)(i), they did not pay attention to the points of application of the forces concerned. In (a)(ii), some candidates did not explicitly point out the directions of the net force acting on the hanging mass and the resulting acceleration. Weaker ones held that there was acceleration even though they stated that the forces were balanced. Parts (a)(iii) and (b) were quite challenging. Candidates had to realise that the total mass of the system was constant (i.e. (M + 0.1) kg) throughout the experiment. Thus, only the more able ones obtained the correct equation of a straight line in (a)(iii) and found M correctly in (b).
5	Candidates' performance was fair in general. Some candidates failed to relate the average thrust to the rate of change of momentum of the exhaust gas in (a)(i). In applying Newton's laws of motion to find the rocket's acceleration in (a)(ii), weaker candidates omitted the weight mg or wrongly took the net force as $F_{thrust} + mg$. Candidates performed poorly in (a)(iii). Not many were able to point out that the average thrust remained the same while the rocket's mass decreased. A few candidates mistook the period of the satellite around the Earth as 1 year or 365 days in (b)(i). In (b)(ii), only the more able ones knew how to make use of $\frac{GM}{R^2} = g$ to tackle this part.
6	Candidates' performance was satisfactory. In (a)(i), some candidates were not aware that the frequency of red light is an invariant, i.e. irrespective of the medium concerned. A few candidates made mistakes in identifying the correct angles of incidence and refraction in (a)(ii). Part (a)(iii) was well answered. Most understood the nature of the magnified image in (b)(i). Just a few failed to obtain the correct separation between O and L in (b)(ii). Not many obtained full marks in (b)(iii). Common mistakes included drawing light rays without arrows and inappropriate use of solid and dotted lines. In (b)(iv), some confused diffraction and refraction in explaining the colour edges of the image formed from a black-and-white slide.

7	This question tested candidates' knowledge and understanding of eddy currents and their applications. The performance was poor in general. In (a)(i), not many candidates identified the correct direction of movement of the metal sheet. Most knew how eddy currents were induced, however, some forgot to mention the relative motion between the plate and the magnet. In (a)(ii), quite a number of the candidates omitted the electrical energy produced in the process. In (a)(iii), very few realised that eddy braking operates only when the vehicle is moving. Some wrongly held that frictional braking was more effective or eddy braking would generate an enormous amount of thermal energy. Part (b) was well answered. Not many stated the correct term 'lamination' in answering (c). Some candidates misunderstood part (d), using the production of eddy currents due to changing magnetic field instead of the magnetic field generated by eddy currents in their answer.
8	Candidates performance was satisfactory. Many candidates realised that resistors R and S were in parallel and thus answered (a)(i)(ii) correctly. Weaker candidates made mistakes in the units of currents or mistook 9 V to be the p.d. across the two parallel branches. Parts (a)(iii)(iv) were well answered. In (b), very few knew the purpose of introducing a protective resistor R in the branch with an ammeter. Some wrongly stated that the ammeter reading would be infinite without R, or a short circuit would occur if R was connected in parallel with the ammeter.
9	This question tested candidates' knowledge and understanding of radioactivity in the context of radioactive potassium contained in bananas. The performance of candidates was good. In (a)(i), most candidates knew that β decay occurred. Candidates' performance was fair in (a)(ii) as some explained the answer in terms of the ionising power or range of β particles instead of penetrating power. Many candidates knew how to tackle part (b). However, quite a number of them made mistakes in unit conversions or mistook N as the number of moles of radionuclides.

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	17	Part (a)(i) revealed that many candidates did not fully understand the concepts of parsec and angular size. Quite a number of them were not aware that the angle must be in radian when calculating the angular size. In (a)(ii), most candidates were able to start with Kepler's third law but less able ones failed to compare the Sgr A*-*X* and Sun-Earth systems in order to find the mass of Sgr A*. In (b)(i), candidates knew that the radial velocity could be deduced using the Doppler effect. In (b)(ii), most knew that star *X* was at *D* around the year 2002. However, few could correctly explain the fact that Sgr A* is at position 2. Some candidates confused radial velocity and orbital speed. In (c), a considerable number of them mistakenly used the radial velocity as the escape velocity to calculate the radius of the black hole.
2	64	In (a), most candidates realised that the atom would collapse according to Rutherford's model but some did not give a reason. A few candidates had no idea of the circular motion of the electron and held that it would hit the nucleus due to electrostatic attraction. Candidates did poorly in (b)(i) and the responses were quite random. (b)(ii) was well answered. Most managed to find the wavelength but quite a number of them failed to state the correct colour. Candidates' performance in (b)(iii) was fair. Some did not know the quantum nature of photons and stated that the photon lost some energy to the atom and left. In fact an atom would absorb the whole photon if the photon energy was larger than the ionization energy. Some of them perhaps confused this with excitation in which only a certain amount of energy could be absorbed and concluded that the photon would not be absorbed while the atom was not affected. In (b)(iv), not many were able to mark the two electron transitions for the visible lines correctly. Some candidates omitted those transitions to $n = 1$. Quite a lot of them did not draw the energy level diagram in a conventional manner, i.e. the transitions were not drawn in groups or the diagram was drawn horizontally.
3	87	In (a), very few candidates were able to point out that a more massive vehicle required a larger force/power for acceleration/deceleration. A common misconception was that a larger force/power was for maintaining the speed of a more massive vehicle. Part (b) was well answered. A few candidates mistook 220 V as the peak voltage while weaker ones treated kW h as a unit of power. Candidates did poorly in (c). As candidates had to tackle the questions from first principles using relevant data from the information given, not many were able to answer (c)(i)(ii) correctly. Weaker ones mixed up input and output powers or made mistakes in unit conversions. Candidates' performance in (d) was fair. It seems that they did not fully understand how a regenerative braking system works. Quite a number of them wrongly chose Mode 3 (driving on a highway) to be the situation in which regenerative braking would be the most effective among the situations given.

4	32	In (a), candidates were required to distinguish the parts of the bifocal lens for viewing distant and near objects respectively. Although most were able to deduce the far point distance of the unaided eyes in (a)(i), some confused the two parts of the lens when dealing with near point *N* in (a)(ii) using the lens formula. Weaker ones did not know that one dioptre, representing the power of a lens, corresponds to a focal length of one metre. Many candidates failed to draw a correct ray diagram showing how the near point of the unaided eyes was corrected by the lens. In (b)(i), candidates were asked to interpret an ultrasound A-scan display graph and extract relevant information from it to find the thickness of the eye lens. Most candidates were able to identify the time interval corresponding to the echoes produced at the boundaries of the eye lens and found the answer using the echo time formula. Some mistook the echo from the retina and obtained a centimetre thickness for the eye lens. This revealed that they had no idea about the size of the eye ball, which is about 2 cm in diameter. A few candidates made mistakes in manipulating microsecond (μs) time intervals. In (b)(ii), most candidates correctly chose 15 MHz rather than 3 MHz ultrasound for the A-scan as it provided a higher resolution. A few picked 3 MHz ultrasound and held that it was less harmful or it had a higher penetrating power. Less than half of the candidates were able to give examples of medical applications of ultrasound in (b)(iii) other than its diagnostic medical applications.