Candidates' Performance

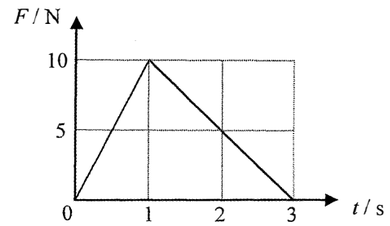
Paper 1

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 17. Items where candidates' performance was typically weaker will be discussed below.

6.

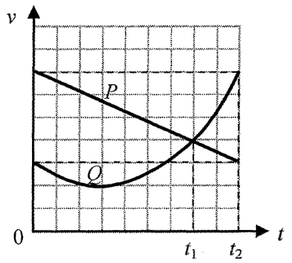


An object of mass 3 kg is initially at rest on a smooth horizontal ground. A force F is applied horizontally to the object such that the magnitude of F varies with time t as shown. What is the speed of the object at $t = 3$ s ? Neglect air resistance.

A.	2.5 m s^{-1}	(10%)
* B.	5 m s^{-1}	(50%)
C.	10 m s^{-1}	(22%)
D.	15 m s^{-1}	(18%)

50% of the candidates managed to use the graph to find the final speed of the object.

9.



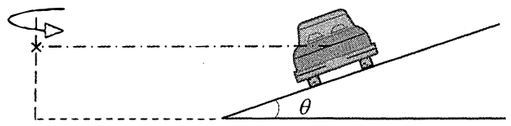
The figure shows the velocity-time (v-t) graph of two cars P and Q travelling along the same straight road. At $t = 0$, the cars are at the same position. Which deductions about the cars between $t = 0$ and $t = t_2$ are correct ?

(1) P and Q are always travelling in the same direction.
(2) At $t = t_1$, the separation between P and Q is at a maximum.
(3) At $t = t_2$, Q lags behind P.

A.	(1) and (2) only	(18%)
B.	(1) and (3) only	(30%)
C.	(2) and (3) only	(12%)
* D.	(1), (2) and (3)	(40%)

About one-third of the candidates did not realise that the separation between P and Q is at a maximum at $t = t_1$.

10.



The figure shows the rear view of a car of mass m which travels along a circular road banked with an angle θ to the horizontal. The car moves at a certain speed such that it experiences **no frictional force along the inclined surface**. Which of the following represents the centripetal force on the car ?

A.	$mg\sin\theta$	(31%)
B.	$mg\sin\theta\cos\theta$	(21%)
C.	$\dfrac{mg\cos\theta}{\sin\theta}$	(15%)
* D.	$\dfrac{mg\sin\theta}{\cos\theta}$	(33%)

About one-third of the candidates were able to find the centripetal force by resolving the components of the normal reaction.

14.

Two pulses of the same shape travel along a stretched string with one end fixed to the wall as shown above. Which of the following can be the resultant waveform at different instants later ?

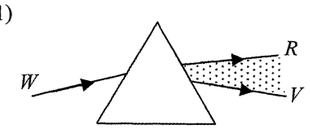
(1) (2) (3)

A.	(1) only	(30%)
B.	(3) only	(14%)
C.	(1) and (2) only	(15%)
* D.	(2) and (3) only	(41%)

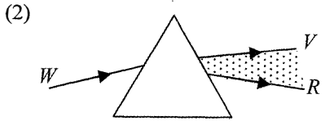
Almost 60% of candidates had difficulty with this question which suggests that a majority were not familiar with the reflection of wave pulses at a fixed end.

17. Which diagrams below correctly show the spectra formed from white light by a glass prism and a diffraction grating respectively ? It is known that red light travels faster than violet light in glass. (R = red, V = violet, W = white)

(1)



(2)



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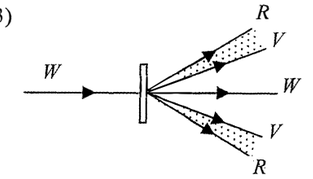
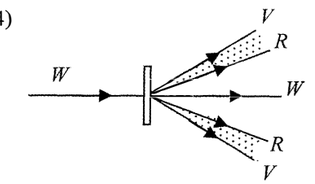


(4)



* A.	(1) and (3) only	(45%)
B.	(1) and (4) only	(28%)
C.	(2) and (3) only	(18%)
D.	(2) and (4) only	(9%)

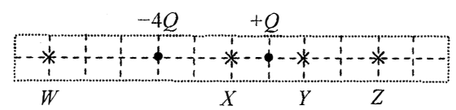
Less than half were able to identify the two correct spectra formed from white light in the diagrams.

20. Which of the following gives the order of magnitude of the wavelengths of ultra-violet radiation and microwave in a vacuum ?

	ultra-violet radiation	microwave	
* A.	10^{-8} m	10^{-2} m	(39%)
B.	10^{-8} m	10^{-5} m	(30%)
C.	10^{-10} m	10^{-2} m	(18%)
D.	10^{-10} m	10^{-5} m	(13%)

Over 40% of the candidates choose an incorrect answer with an order of magnitude of the wavelength of microwave at 10^{-5} m.

22.

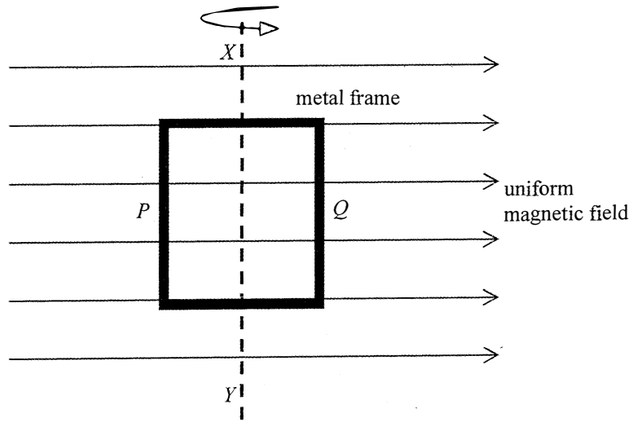


Two point charges $-4Q$ and $+Q$ are fixed as shown. At which point indicated in the figure is the resultant electric field due to these two charges zero ?

A.	W	(8%)
B.	X	(29%)
C.	Y	(30%)
* D.	Z	(33%)

About 30% of the candidates choose 'Y' which suggests they forgot to take into account the inverse square relationship between the electric field and the distance from the charge.

24.



A rectangular metal frame is made to rotate steadily about its axis XY in a uniform magnetic field. At the instant shown, the frame is in the plane of the paper and side P is moving out of the paper while side Q is moving into the paper. Which statement is **INCORRECT at this instant** ?

A.	The induced e.m.f. in the frame is at a maximum.	(17%)
* B.	The induced current produced in the frame is flowing in anti-clockwise direction.	(44%)
C.	The magnetic force acting on side P is in a direction pointing into the paper.	(26%)
D.	The magnetic forces acting on the frame produce a moment opposing the frame's rotation.	(13%)

About 40% of the candidates may not have understood that the magnetic force as well as the resulting moment are opposing the frame's rotation.

31. Which of the following nuclear reactions is/are **spontaneous** reaction(s) ?

(1) $^{24}_{11}\mathrm{Na} \rightarrow {}^{24}_{12}\mathrm{Mg} + {}^{0}_{-1}\mathrm{e}$

(2) $^{10}_{5}\mathrm{B} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{7}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He}$

(3) $^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$

* A.	(1) only	(36%)
B.	(3) only	(23%)
C.	(1) and (2) only	(20%)
D.	(2) and (3) only	(21%)

Over 40% of the candidates choose an answer that stated nuclear fusion is a spontaneous reaction. This percentage was higher than expected.

32. Workers in nuclear power plants wear clothes with film badges to measure the dosage of radiation received over a period of time. Which type of radiation below **CANNOT** be monitored by the film badges ?

* A.	α-radiation	(35%)
B.	β-radiation	(2%)
C.	γ-radiation	(27%)
D.	X-rays	(36%)

Just over one-third of the candidates had taken into consideration the possible range of radiation in the air.

Section B (conventional questions)

Question Number	Performance in General
1	This question tested the variation of resistance with temperature as well as the measurement of specific heat capacity using a resistance thermometer, assuming a linear resistance-temperature relationship. Parts (a)(i)(ii) were in general well answered. In (b), some candidates confused experimental value with actual value. More able candidates were able to explain why the experimental value is lower than the actual value.
2	This question tested candidates' knowledge and understanding on gas laws. In general, candidates' performance was good. Some candidates, however, applied the equation $pV = nRT$ without first converting the data into S.I. units, while a few did not change the temperature from Celsius scale to Kelvin scale.
3	This question was on the projectile motion of an acrobat. Candidates' performance was satisfactory. In (a), some candidates tried to solve the problem by using an equation of motion instead of conservation of energy to find v_B. Most candidates were able to apply correct equations to find the answers to (b)(i)(ii) although a few got v_x, v_y and v_B mixed up.
4	This question tested candidates' knowledge and understanding of motion, namely a block on an inclined plane. Candidates' performance was satisfactory. A few candidates failed to describe correctly the motion in (a), which was based on the velocity-time graph given. In (b)(i), most candidates worked out the correct acceleration using the graph but some overlooked calculating the magnitude. Part (b)(ii) was well answered. In (c), many candidates were able to draw a free-body diagram showing the forces (with labels) acting on the block as it moved up the plane. However, some candidates wrongly included the resultant force and/or the weight component along the plane ($mg\sin\theta$) in addition to mg. They also wrongly drew the direction and line of action of the frictional force. Part (d) was poorly answered. Only the most able candidates were able to set up correctly two equations for the forces acting on the block as it decelerated up and accelerated down the inclined plane.
5	This question required candidates to describe how to measure the acceleration of a train using the apparatus provided. Their general performance was poor. Many of them did not mention procedures such as connecting the ends of the string to the metal ball and to the hole of the protractor. Only the most able ones showed an understanding of the proper orientation of the protractor and the correct position of the string when the metal ball accelerated forward with the train (inclined to the vertical at angle θ in the opposite direction). Some candidates did not mention the measurement to be taken and they just stated the result $a = g\tan\theta$ without the mathematical derivation required.
6	This question was based on a passage describing the formation of a mirage. The situation was unfamiliar to candidates and their general performance was unsatisfactory. In (a), few were able to state correctly an essential condition for a mirage to be observed based on the information given. Parts (b)(i)(ii) were well answered. A few candidates did not know how to find the value of θ_1 in (b)(i) using the relation $n\sin\theta$ = constant. Candidates answered part (c) poorly. Only the most able ones explained correctly why the 'water source' remained a distance L away.
7	Part (a) was well answered. Some candidates made mistakes in converting units when calculating the fringe separation. In (b), few candidates realized that interference did occur but was unobservable as the sources were incoherent. Many thought that an interference pattern with smaller fringe separation formed would occur as the source separation was greater. Some confused phase and coherence, and stated 'the interference was unobservable because they were out of phase'. Quite a number of them sketched straight lines instead of curves for the antinodal lines in (c). In (d)(i), more than half of the candidates incorrectly read the value of y even though correct antinodal lines were drawn as they might have overlooked the scale (10 mm per division) given. Part (d)(ii) was poorly answered as most candidates did not know the geometrical constraints in estimating the fringe separation.

Question Number	Performance in General
8	This question was well answered. In (a), a significant number of candidates misunderstood the phrase 'per km' and therefore wrongly divided the resistance by 1000 m. Some confused surface area with cross-sectional area and thus failed to find the correct answer. In (a)(iii), many candidates did not realise that electric shock is essentially due to the large amount of current passing through the body but not merely because of high voltage. Few were able to mention that negligible current would pass through the bird's body. Quite a number of them wrongly thought that the cable was covered with insulating material. Answers like 'The potential difference across the bird is zero' or 'There is no current passing through the bird's body' were common. Part (b) was well answered. A few candidates forgot to multiply the resistance per km (0.05 Ω km^{-1}) by 10 km in (b)(ii). In (b)(iii), the terms stated by some candidates were not precise, for example, 'cable' was used instead of 'wire', 'sliced iron' was used instead of 'laminated core' etc.
9	In (a), some candidates tried to explain the direction of the electromagnetic force acting on the rod rather than to describe its subsequent motion. In (b)(i), most were able to apply the definition of moment ($F \times d$) to solve this problem but many of them failed to identify the correct value of d and ended up with an incorrect numerical answer. Some candidates did not convert cm into m in their calculations. Incorrect equation (e.g = $B = \frac{\mu_0 \ell}{2\pi r}$) or unit (e.g. Bq, Wb) were quoted in (b)(ii). In (c)(i), some candidates treated the rod as a bar magnet and sketched the field pattern wrongly. Common errors included incorrect direction of field lines, none of the field lines crossed the rod or uniform field patterns. Not many were able to state that the rod performs circular motion in an anti-clockwise direction in (c)(ii).
10	Candidates only did well in (a). A few candidates had difficulty in dealing with the units eV and J. In (b)(i), not many knew that the energy used for overcoming the repulsion between the two positive nuclei became electrical potential energy. Some wrongly thought that it turned into kinetic energy, heat or nuclear energy. In (b)(iii), most candidates failed to relate the average kinetic energy of the nuclei to the large amount of work done needed. A few even wrongly employed E = 17.58 MeV in (a) in their calculations.

The mean percentage correct achieved by the candidates was slightly lower than 50%. Most markers agreed that there was an appropriate balance between questions testing basic knowledge and those testing higher-order skills.

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	21	Candidates' performance in (a) was fair. Most of them failed to state the concise meaning of radial velocity of a star observed on Earth. For the calculation of orbital radii in (b), candidates were able to use the information given in the graph. Many had difficulties in understanding the binary stars system and therefore failed to set up a correct equation of motion in (c). Some candidates even treated the circular motion of star 1 as if it was a single star. Most candidates managed to give correct explanations concerning the suitability of using the spectrometer in (d).
2	66	Part (a) was well answered. Most candidates understood the physical meaning of ground state. In (c), some of the candidates managed to find the relation correctly but just wrote $E = pc$ instead of expressing p explicitly in terms of E and c. (d)(i) was in general well answered. Quite a lot of candidates showed that the energy was large enough to excite the hydrogen atoms to the third excited state but not why there was not enough energy to excite it to the fourth excited state. Some candidates arrived at negative ΔE by using $E_1 - E_4$. In (d)(ii), few candidates were able to apply $n\lambda = 2\pi r$ to find the wavelength. Some assumed that the K.E. of the electron equals to its P.E. at E_4 but actually K.E. = –P.E. Not many indicated all the transitions correctly in (d)(iii). Most of them only drew 4 to 5 lines and some with incorrect arrows.
3	87	Part (a)(i) was well answered. (a)(ii) revealed that many candidates were weak in explaining principles of physics. Quite a number of them stated that longer cooling time was due to 'heat lost to surroundings' but not the fact that thermal energy is being removed. In (b), most were able to work out the average electrical power input and the COP. However, many did not fully understand the concept that 1 J of electrical energy consumed by the air-conditioner/compressor can remove 3.24 J of thermal energy from the room. In (c)(i), quite a number of the candidates made mistakes in the direction of the flow of refrigerant. This revealed that they were not familiar with the working principle of a 'reverse-cycle air-conditioner' (RCAC) and the functions of different components in it. As a result, many failed to state in which component the refrigerant had the highest temperature. Part (c)(ii) was generally well answered despite some wrong statements such as reversing the direction of electric current could convert a cool-only air-conditioner into an RCAC.
4	26	Part (a)(i) was well answered. Many failed to deduce the gain of pressure in (a)(ii). In (b)(i), some candidates were unable to state concisely the physical significance of the loudness curve being higher at both low and high frequencies. Not many candidates managed to identify the correct loudness curve in (b)(ii) with appropriate explanations. Part (c) was in general well answered although a few of them were not familiar with logarithmic operations.

School-based Assessment

All school candidates sitting for HKDSE Physics are required to participate in School-based Assessment (SBA). For the 2015 examination, 12 144 students from 436 schools submitted their SBA marks this year. The schools were divided into 24 groups and the implementation of SBA by the teachers in each group was monitored by a District Coordinator (DC). The DCs were also responsible for reviewing the submitted samples of students' work.

A statistical moderation method was adopted to moderate the SBA scores submitted by schools. Outlier schools after statistical moderation were identified for further follow-up by the SBA Supervisor. 59.9% of schools fall into the 'within the expected range' category, with 24.3% of schools having marks slightly higher than expected, and 15.8% of schools having marks slightly lower than expected. This is encouraging as the data shows that the majority of the teachers do have a good understanding of SBA implementation, and hence the marking standards are generally appropriate.

Some schools were visited by the DCs to gather first-hand information on the implementation of SBA in schools. From the feedback of teachers and the DC's reports, the assessment process was smooth and effective in general. SBA marks were submitted on time and all requirements of SBA were met. The major observations for this year's SBA are:

1. This was the second year that students were required to write up a detailed report or conduct an Investigative Study as a mandatory requirement of SBA. Most schools opted for the former while an increasing number of schools implemented Investigative Study for SBA, in which students were asked to plan and design an experiment to come up with possible solutions to an "open-ended" task. The goal of a detailed report was to help students develop the skills to handle tasks with less structure. The design, format and tasks of those experiments were diverse and most of them were appropriate. There were a few cases that students should have been provided opportunities for more demanding tasks through which they could demonstrate their science process skills.

2. Based on the SBA submission, the majority of teachers submitted a total of 4 to 5 experiments for assessment, which was more than the minimum requirement. Teachers selected a diverse range of experiments as practical tasks, and these tasks were of an appropriate level of difficulty and relevant to the curriculum. The popular list included projectile motion, refractive index and critical angle of a glass block, focal length of a lens, wavelength of visible light, measurement of resistance of a wire and magnetic flux of a current-carrying solenoid. Some experiments involve the verification of Boyle's Law, Ohm's Law, inverse square law, centripetal force and interference of waves. It was encouraging that some teachers provided extended questions to stretch high-tier students to experience a full range of science process skills.

3. Most reports were satisfactorily marked. Besides indicating marks awarded to different parts of the reports, teachers are advised to provide assessment criteria and written feedback in the reports wherever appropriate in order to enhance assessment for learning.

4. In general, most of the tasks selected or devised are suitable for SBA as well as for students' learning. However, there were a few cases in which the experiments chosen were too trivial for assessment (e.g. measurement of mass by a lever). These tasks were considered to be too simple with respect to the level of science process skills to be tested. The assessment aims and skills required were reiterated in the SBA Conference and follow-up by respective DCs was done. Teachers are expected to exercise professional judgment in selecting and devising tasks/worksheets that allow students to demonstrate their science process skills and competencies.

It must be stressed that students should complete the assessment tasks honestly and responsibly in accordance with the stipulated requirements. They will be subject to severe penalties for proven malpractice, such as plagiarizing others' work. The HKDSE Examination Regulations stipulate that a candidate may be liable to disqualification from part or the whole of the examination, or suffer a mark penalty for breaching the regulations. Students can refer to the information leaflet *HKDSE Examination - Information on School-based Assessment* (http://www.hkeaa.edu.hk/DocLibrary/Media/Leaflets/SBA_pamphlet_E_web.pdf) for guidance on how to properly acknowledge sources of information quoted in their work.

Acknowledgements

Material from the following publications/web-sites has been used in question papers in this volume:

Merriam-Webster	*Protractor* http://visual.merriam-webster.com/science/measuring-devices/measure-angles/protractor.php
Universities Space Research Association	*Highway Mirage* http://epod.usra.edu/blog/2010/03/highway-mirage.html
Moment of Science	*Why aren't bird electrocuted when they perch on power lines?* http://indianapublicmedia.org/amomentofscience/bird-on-a-wire/

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