Candidates' Performance

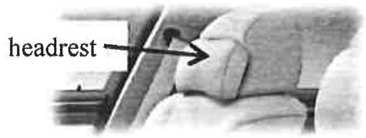
Paper 1

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 18. Items where candidates' performance was typically weaker will be presented below with mean percentage statistics.

5.



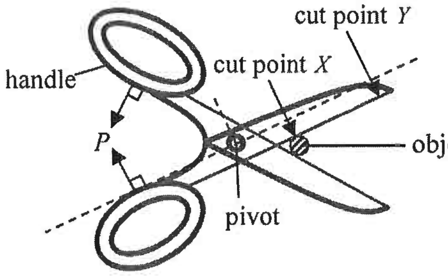
For a car travelling on a highway, which of the following statements about the safety design of the headrest is/are correct ?

(1) As the headrest is soft, it can reduce the force exerted on the passenger's head during impact.
(2) It can minimise injury of the passenger when the car is struck by another one from behind.
(3) It can minimise injury of the passenger when the car brakes suddenly.

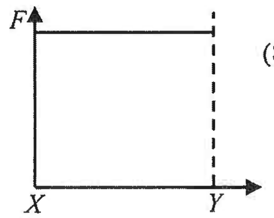
A. (1) only (25%)
B. (3) only (10%)
* C. (1) and (2) only (52%)
D. (2) and (3) only (13%)

Over one-third of the candidates did not think that statement (2) could be correct.

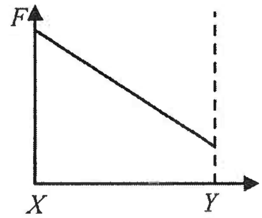
7. The figure shows that a pair of forces P of constant magnitude is applied at right angles to the handles of a pair of scissors in order to cut an object.



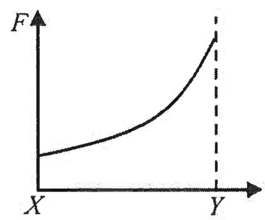
Which graph below best shows the variation of force F produced at cut point from X to Y when the pair of scissors is closed ?

A.


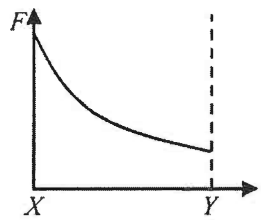
(8%)

B.


(43%)

C.


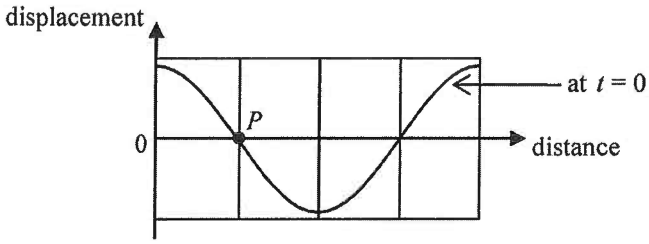
(20%)

*D.


(29%)

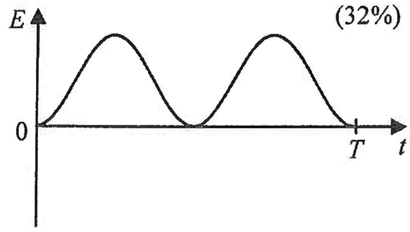
While over 70% of the candidates indicated knowledge that the force is larger at cut point X, less than 30% of them fully understood how the force varies when the pair of scissors is closed.

12. The figure shows part of the displacement-distance graph of a travelling wave of period T at time $t = 0$. P is a particle on the wave.

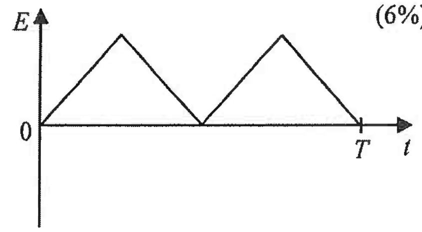


Which graph below correctly shows the variation of the particle's kinetic energy E within a period starting from $t = 0$?

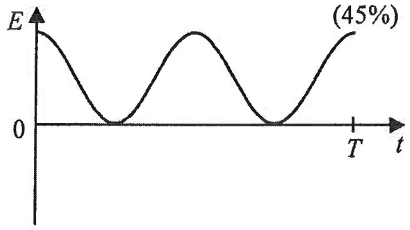
A. (32%)



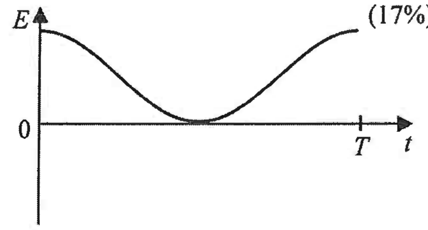
B. (6%)



*C. (45%)



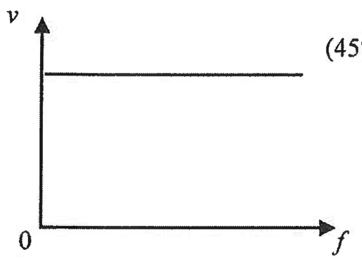
D. (17%)



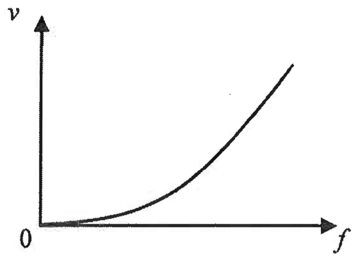
Less than half of the candidates were able to obtain the correct answer of which the particle's kinetic energy is at a maximum at $t = 0$.

16. A transverse wave propagates along a stretched string. Which graph below correctly shows the variation of the speed v of the wave with its frequency f?

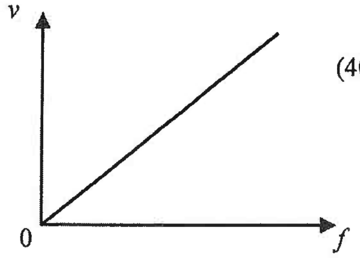
*A. (45%)



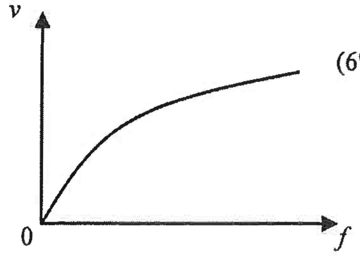
B. (9%)



C. (40%)

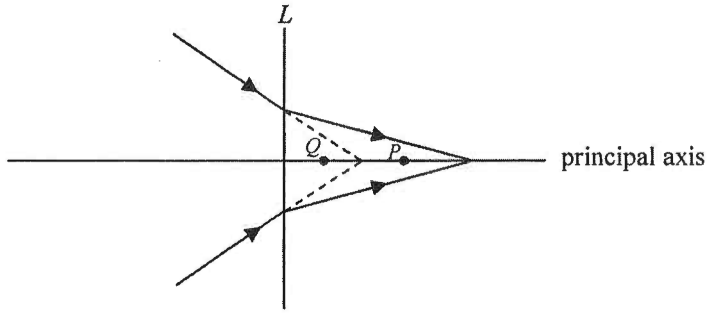


D. (6%)



40% of the candidates thought that the speed v increases linearly with frequency f and chose option C, which suggests that some candidates might have assumed the wavelength, instead of the speed, remains unchanged on a stretched string.

18.

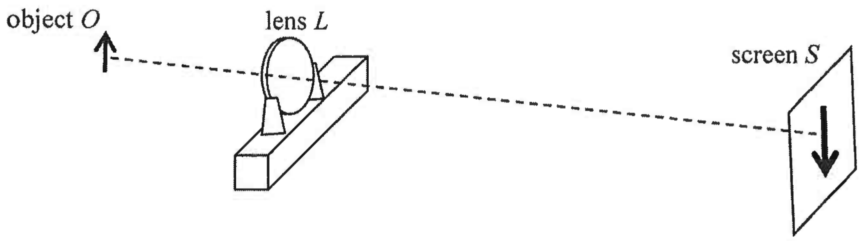


Referring to the above ray diagram, what kind of lens is represented by L ? Which point, P or Q, can be its focus ?

	lens L	**focus**	
*A.	concave	P	(45%)
B.	convex	P	(22%)
C.	concave	Q	(20%)
D.	convex	Q	(13%)

Candidates choosing options B and D suggests that they did not have a basic understanding of the converging and diverging properties of lenses.

20. The figure shows an enlarged sharp image of an object O formed on a screen S by a convex lens L.



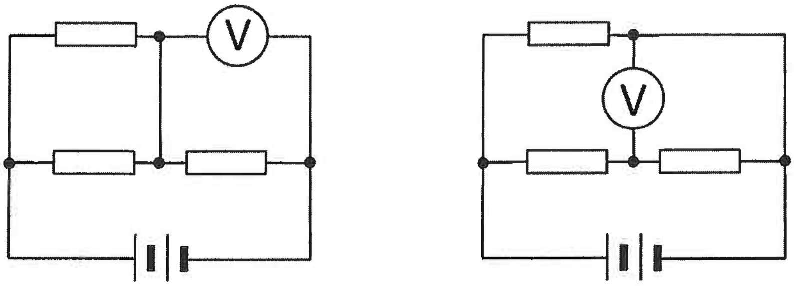
Which of the following can give a diminished sharp image on the screen ?

(1) Keeping the positions of O and L unchanged, move S suitably closer to L.
(2) Keeping the positions of L and S unchanged, move O suitably farther away from L.
(3) Keeping the positions of O and S unchanged, move L suitably closer to S.

A.	(1) only	(13%)
*B.	(3) only	(31%)
C.	(1) and (2) only	(14%)
D.	(2) and (3) only	(42%)

Less than one-third of the candidates were able to answer this question correctly. It seems that many candidates were not aware that a certain object distance only corresponds to a unique image distance.

23. Three identical resistors, a battery of negligible internal resistance and an ideal voltmeter are connected to form Circuits (a) and (b) respectively.



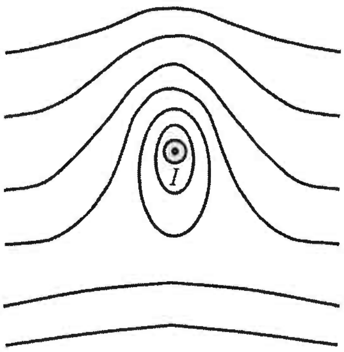
Circuit (a) Circuit (b)

Given that the voltmeter reading is 8 V in Circuit (a), what is the voltmeter reading in Circuit (b) ?

A.	4 V	(25%)
*B.	6 V	(32%)
C.	8 V	(24%)
D.	12 V	(19%)

Just under one-third of the candidates were able to tackle the problem by treating the branch with the ideal voltmeter as an open circuit.

26. The figure below shows the magnetic field pattern on a horizontal surface around a long vertical straight wire carrying a steady current I pointing out of the paper. The Earth's magnetic field is **NOT** neglected.



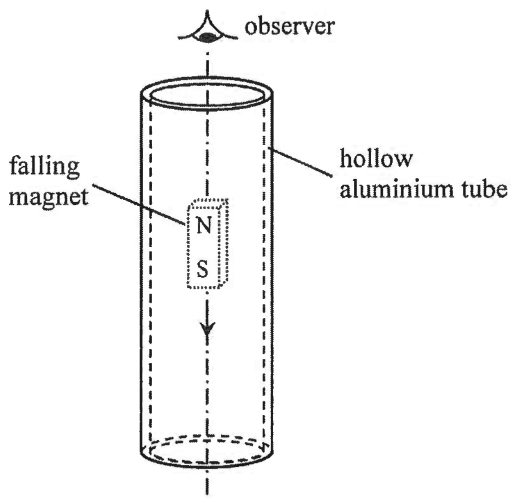
Top view

What are the directions of the following ?

	the horizontal component of the Earth's magnetic field	**the magnetic force experienced by the current-carrying wire**	
*A.	←	↓	(42%)
B.	←	↑	(25%)
C.	→	↓	(13%)
D.	→	↑	(20%)

Of the two-thirds of the candidates correctly identifying the direction of the magnetic field, just over 40% were also able to get the direction of magnetic force correct.

28.



When a small strong magnet falls through a hollow aluminium tube as shown, eddy currents are induced. Which of the following correctly describes the direction of current induced in the tube when viewed by an observer from above ?

A.	clockwise both above and below the magnet	(17%)
B.	anti-clockwise both above and below the magnet	(19%)
C.	clockwise above the magnet and anti-clockwise below the magnet	(32%)
*D.	anti-clockwise above the magnet and clockwise below the magnet	(32%)

Only one-third of the candidates were able to apply Lenz's law in answering this problem.

32. The decay constant of a radioisotope of an element

A.	is random.	(22%)
B.	depends on pressure and temperature.	(8%)
C.	is directly proportional to the number of nucleons in the isotope.	(21%)
*D.	is an identifying characteristic of that isotope.	(49%)

Just under half of the candidates fully understood the uniqueness of decay constant.

Section B (conventional questions)

Question Number	Performance in General
1	This question examined candidates' knowledge and understanding of heat transfer. It was generally well answered. Most candidates obtained the correct answer in (a). Candidates' performance was good in (b)(i) though a few misunderstood the question and tried to explain 'why the soup should be kept at 96 °C'. In (b)(ii), many omitted the contribution of the container in the calculation. Some candidates mistook the temperature drop (9 °C) as the final temperature. Most candidates did well in (b)(iii). A few wrongly assumed that the temperature drop would remain the same despite the temperature difference becoming smaller.
2	Candidates' performance was satisfactory. Some candidates failed to indicate where the force should act in (a)(i). In (a)(ii), some calculated the force by the steam or the force due to atmospheric pressure instead of the force keeping the piston stationary. Weaker candidates mistook 'force = pressure/area'. In (a)(iii), a few took the temperature of the steam to be 273 °C instead of 237 °C. Some mistook the number of mole *n* to be 1. In (b)(i), most managed to find the work done by considering the gain of kinetic energy of the jet fighter. Many candidates, who employed work done equals force × distance, wrongly used the initial force and/or mistook the distance travelled as the product of the final velocity and time taken. Some candidates only found the net force instead of the work done or considered the work done as mass × acceleration or force × velocity. Candidates did well in (b)(ii). Some struggled to obtain 'an average value' for the average acceleration found. Most candidates knew that the acceleration was decreasing in (b)(iii) but were not able to clearly explain why. Some confused 'decreasing' with 'decreased' and stated that 'friction reduces the speed and hence acceleration is decreasing'.
3	This question tested candidates' knowledge and understanding in Electromagnetism in the context of magnetically levitated trains. The overall performance was fair. In (a), most candidates were able to point out the lowered resistance allowed a larger current flow. However, a number of them described the current as eddy currents. A considerable number of candidates wrongly believed that 'unlike poles repel each other' in (b) and a few used 'positive pole/charge' to describe magnetic poles. Candidates' performance in (c) was fair. Although most were able to explain the situation in general terms, their descriptions were far from precise. Some simply wrote 'no friction' instead of no friction between the train and the track. Few pointed out explicitly that 'air resistance' was the only resistive force that needed to be overcome.
4	Candidates' performance was satisfactory. Some candidates wrongly arranged the speeds in the opposite order in (a). In (b), a lot of the candidates confused the following: acceleration, weight, acceleration due to gravity and velocity. In (c)(i), most were able to describe the energy conversion correctly. However, some failed to point out that the energy conversion from *B* to *C* only involved '*part* of the sphere's kinetic energy'. Part (c)(ii) was well answered. Candidates were able to use energy conservation to solve the problem. About half of them managed to tackle (c)(iii) by resolving the components of the initial velocity of the sphere. Some even tried to work out the time of flight separately based on the independence of horizontal and vertical motions.
5	Candidates' performance was fair in general. In (a)(i), most were able to indicate the forces acting on the block when it was treated as a free body. However, a few candidates made mistakes in either the direction or the labelling of the normal reaction. Candidates' performance in (a)(ii) was poor. Not many managed to resolve the forces and correctly set up the equations required. Some wrongly recalled $R = mg \cos\theta$ for the reaction in such a situation that involved an extra force *F*. A lot of the candidates answered (b)(i) correctly though some of them used *F* (the force being removed) to find the acceleration. Part (b)(ii) was unfamiliar to candidates and some failed to realise that the perpendicular component of *F* had a part to play in such a situation.

6	This question tested candidates' knowledge and understanding in an experiment to find the speed of sound in air. In general, candidates' performance was fair. In (a), quite a number of candidates did not understand how the experiment worked and thus failed to indicate the appropriate location where a sharp loud sound should be produced. Many candidates obtained full marks in (b)(i). A few took the average value of all the four timer readings. Weaker candidates confused microphones with loudspeakers and thought that it was an experiment about the interference of sound, thus employing the wave equation $v = f\lambda$. About half of the candidates failed to score in (b)(ii). Many answers were in fact not adjustments to the experimental setting, e.g. 'repeat the experiment and take average', 'surround the set-up with sound-proof materials', etc.
7	Candidates did well in (a)(i)(ii). In (a)(iii), most knew that total internal reflection occurred, however, some candidates just gave the general conditions for not having total internal reflection instead of $\theta \geq 30°$ as required. Part (b) was unfamiliar to candidates. In (b)(i), not many realised that the light taking different paths within $\theta = \pm 30°$ would reach the sensor at different arrival times. In (b)(ii), very few candidates were able to explain how the cladding's refractive index n_c would affect the critical angle which subsequently allowed a narrower light beam to undergo total internal reflection. Many did not understand the situation stating that n_c had no effects on the width of the light pulse.
8	This question tested candidates' knowledge and understanding of circuits in the context of a car's lighting system. The overall performance was fair. In (a), few were able to point out that light bulbs L_1 and L_2 were shorted. Many held that no current passed them was due to 'open circuit' or 'their resistances are lower than those of the bulbs in the parallel branch'. Part (b) was well answered. Most knew that the potential difference was 12 V and indicated the correct directions of currents. Many candidates figured out the light bulbs were all connected in parallel and obtained some marks in (c). A few made careless mistakes in finding the equivalent resistance. Most candidates understood the function of fuse and answered part (d) correctly.
9	Candidates' performance was poor. Although most candidates were able to show the correct direction of the electric field in (a), many failed to draw evenly spaced, parallel field lines properly. In (b)(i), not many were able to use the correct component of force or moment arm to find the moment acting on the rod. Some mistook the length of the rod or even the separation of the plates as the moment arm. Wrong units for the moment such as J or N were common. Most candidates answered (b)(ii) correctly. Incorrect units for the electric field were found occasionally. Many candidates wrongly employed equations of force or electric field due to a point charge to tackle (b)(iii).
10	Part (a) was well answered. Some candidates were unable to identify the product X despite they had found the correct proton and mass numbers. In (b), most managed to find the mass defect correctly. Some failed to convert the mass defect to energy in MeV. Weaker ones mistook the energy equivalent of the mass of an α particle as the minimum kinetic energy or omitted the α particle or the proton in finding the minimum kinetic energy. Candidates' performance in (c) was poor. Only a few were able to give correct explanations based on the conservation of momentum. Popular explanations included 'extra energy is needed because of inelastic collision or binding energy', 'to compensate for the energy loss to surroundings' or 'to overcome repulsive forces'.

The mean mark 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	18	In (a), most candidates knew how to find when the explosion occurred although some of them made mistakes in converting units. In (b), some candidates failed to point out that the absolute magnitude corresponds to observing the star as if it were placed at 10 pc. Part (c) was well answered. In (c)(ii), many knew the region on the H-R diagram in which star *X* was located. Most were able to identify features of star *X* that ruled out the possibility of classifying it as a 'red giant'. A few candidates forgot to start with Stefan's law. In (d), some candidates had a misconception that there was no Doppler effect as the distance of the star from the observer did not change.
2	67	Part (a)(i) was well answered. Many candidates misunderstood (a)(ii) and tried to explain why there was such an experimental result instead of giving the implication of the result. In (b)(i), many gave answers like 'current increases due to more photoelectrons' for the situation prior to the voltage being set to 1.7 V but without mentioning what would happen when V = 1.7 V. Candidates did well in (b)(ii). However, some simply took the photon energy hf as the work function or failed to deal the unit eV. In (c)(i), some candidates did not realise that the number of photoelectrons could simply be found from the current. In (c)(ii), not many fully understood how 'stopping potential' and 'maximum kinetic energy of photoelectrons' were related. As a result, few were able to work out the maximum kinetic energy. It seemed that candidates did not have a clear picture of the photoemission process involving the concept of work function. Some thought that the variation in kinetic energy was due to things that had happened when the photoelectrons went from cathode to anode.
3	85	Candidates' performance was only fair. In (a), not many were able to mention that an atom or a nucleus is more stable if it possesses a higher binding energy per nucleon. In (b), many candidates did not understand that 'binding energy' represents the 'energy required to separate the nucleons *completely*'. Weaker candidates held that it was the amount of energy needed to 'bind' the nucleus from its constituent nucleons. For the calculation in (b)(ii), some incorrectly multiplied the binding energy per nucleon by the difference of mass number and atomic number. Less than half of the candidates obtained the correct answer in (c)(i). Many made mistakes in units conversion or in manipulating the efficiency of energy conversion. In (c)(ii), few were able to mention that a chain reaction could not be sustained when the concentration of U-235 in the fuel rods was too low. In (d), most candidates knew the function of moderator in a fission reactor though a few wrongly stated that 'electrons' or 'atoms' were to be slowed down. For those who pointed out that control rods were to absorb neutrons, some did not further explain that they were for controlling the rate of reaction.

4	30	Candidates' performance in (a) was satisfactory. A few did not realise that 'high-speed' electrons and a 'heavy' metal target were necessary for X-rays production. In (b)(i), most candidates were able to relate the higher density or larger effective atomic number of bone with the attenuation coefficients given. In (b)(ii), many knew how to apply the exponential equation to compute the answer, although some wrongly applied the ultrasound intensity reflection coefficient formula in this part. Part (b)(iii) was quite challenging. Many did not fully understand the physics principles involved in X-rays radiographic imaging, namely, how the penetrating power of X-rays depends on their energy and the relation between X-rays attenuation and contrast of image. The lower energy 20 keV X-rays, which is less penetrating, could be effectively attenuated by breast tissue during breast screening. Thus an image of transmitted X-rays with sufficient contrast to distinguish calcified tissues could be obtained. However, the contrast would be poor if highly penetrating 100 keV X-rays were used, as most X-rays penetrated the breast without much attenuation. Part (c)(i) was well answered. In (c)(ii), most were able to mention the multiple angles of exposure and longer exposure time for CT scans. Some misinterpreted the result of the CT scan (clear cross-section image) to account for the higher equivalent dose. Surprisingly, candidates' performance in (c)(iii) was poor. Many answers were not specific enough, taking 'sun, food, water, rock and building' as sources but without mentioning any of its radioactive substance content. Some claimed that electronic devices such as mobile phones were sources while a few confused the terms 'cosmic rays' and 'cosmic radiation'.

School-based Assessment

All school candidates sitting for HKDSE Physics have to participate in School-based Assessment (SBA). For the 2020 examination, 9757 students from 429 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. 57.8% of schools fall into the 'within the expected range' category, with 27.5% of schools having marks slightly higher than expected, and 14.7% 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 about the 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. Based on the SBA reports submitted, most schools opted for a detailed report as an alternative to Investigative Study. The primary goal of a detailed report is to provide students an opportunity to write up a full laboratory report from which science process skills can be assessed. On the other hand, Investigative Study involves an 'open-ended' task in which students are given guidance in designing experiments, making measurements, analysing data and writing reports. Most Investigative Study reports were well written. This reveals that students are motivated and have the capability of performing well in such challenging tasks.

2. The majority of teachers asked students to submit four to five reports of laboratory work for assessment which is more than the mandatory SBA requirement of three reports. Teachers were able to exercise their professional judgment in choosing experiments and setting assessment criteria for SBA, covering both practical and report writing skills. Such a school-based arrangement can accommodate a wide learning spectrum of students via a diverse range of experiments and science process skills. The experiments selected were of an appropriate level of difficulty and relevant to the curriculum. Popular ones included projectile motion, refractive index and critical angle, focal length, wavelength of visible light, internal resistance of a battery and magnetic flux of a current-carrying solenoid. Experiments to verify Boyle's law, Ohm's law,

centripetal force and interference of light were also found. Some laboratory work incorporated challenging extended questions for higher-tier students. Mobile phones were employed as a data logger for physics experiments on some occasions. For example, an acceleration sensor embedded in a mobile phone together with a mobile application allowed students to measure the acceleration inside a lift moving between different floors. In general, experiments utilising mobile phones are encouraged for SBA.

3. Most SBA reports are marked satisfactorily. Besides indicating marks awarded to various parts of the reports, assessment criteria were explicitly provided by teachers for students' information. It is worth noting that teachers should pay more attention to providing written comments as feedback to enhance assessment for learning in the reports. Through scrutinising the reports, some basic science process skills and knowledge seem to be ignored by students, namely, measurements, data presentation and graph plotting. Some students knew little about accuracy and precision of measurement and quite often gave too many significant figures for the data as well as the results drawn. Students tended to join the origin and the last data point by a straight line or even presented a zig-zig curve in graph plotting instead of a line of best-fit. On the other hand, there were good marking practices in the report that highlighted mistakes/errors as feedback to students. Such comments would facilitate learning how to properly conduct an experiment and write a good report in the future.

4. Although most experiments were appropriate for SBA, a few of them were appropriate for teaching rather than assessment. These tasks asked students to perform simple measurements but without further relating these measurements to any physics theory or principles. Teachers are expected to exercise professional judgment carefully in choosing experiments and assessment criteria that provide room for students to demonstrate their science process skills and competencies.

It must be stressed that candidates 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 plagiarising others' work. The HKDSE Examination Regulations stipulate that a student may be liable to disqualification from part or the whole of the examination, or suffer a mark penalty for breaching the regulations. Candidates 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

The following material has been used in question papers in this volume:

BMW	*Headrest* http://www.bmw.com.my/com/en/newvehicles/5series/sedan/2007/allfacts/ergonomics/_shared/img/ergonomics_active_headrest.jpg
Cellphonebot	*LG 1100mAh 3.7V Standard Battery manufactured by LG is compatible* https://cellphonebot.com/less-than-10/lg-1100mah-3-7v-standard-battery-manufactured-by-lg-is-compatible-with-vx3200-vx3300-vx3400-vx3450-vx4650-vx4700-vx5200-vx5300-vx6100-vx8100-vx8300-mm-535-ax4270-ax4750-ax5000-lx225-lx-38304
The Astronomy Picture of the Day (APOD)	*Retrograde motion of Mars* https://apod.nasa.gov/apod/image/0604/Mars2005_6_tezel_f.jpg

The Authority is grateful to publishers/organisations for permission to include the material in the question papers. We apologise for any infringement of copyright in respect of material printed in this volume, for which permission has not been obtained in time or for which the sources could not be traced.

Every effort has been made to trace copyright. However, in the event of any inadvertent infringement due to errors or omissions, copyright owners are invited to contact us so that we can come to a suitable arrangement.