Marking Schemes

This document was prepared for markers' reference. It should not be regarded as a set of model answers. Candidates and teachers who were not involved in the marking process are advised to interpret its contents with care.

General Marking Instructions

1. It is very important that all markers should adhere as closely as possible to the marking scheme. In many cases, however, candidates may have obtained a correct answer by an alternative method not specified in the marking scheme. In general, a correct answer merits ***the answer mark*** allocated to that part, unless a particular method has been specified in the question.

   In the marking scheme, alternative answers and marking guidelines are in $\boxed{\text{rectangles}}$.

2. In the marking scheme, answer marks or 'A' marks are awarded for a correct numerical answer with a unit. If the answer should be in km, then cm and m are considered to be wrong units.

3. In a question consisting of several parts each depending on the previous parts, method marks or 'M' marks are awarded to steps/methods or substitutions correctly deduced from previous answers.

4. In cases where a candidate answers more questions than required, the answers to all questions should be marked. However, the excess answer(s) receiving the lowest score(s) will be disregarded in the calculation of the final mark.

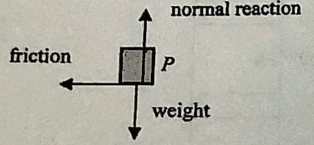
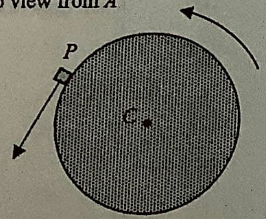
Paper 1 Section A

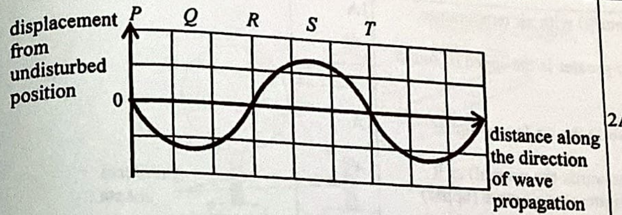
Question No.	Key	Question No.	Key
1.	C (72)	26.	B (49)
2.	B (65)	27.	C (64)
3.	B (49)	28.	C (73)
4.	D (84)	29.	B (44)
5.	B (23)	30.	A (58)
6.	C (59)	31.	A (45)
7.	C (71)	32.	D (68)
8.	D (38)	33.	B (51)
9.	A (77)		
10.	A (33)		
11.	C (55)		
12.	A (83)		
13.	D (49)		
14.	A (44)		
15.	D (58)		
16.	D (52)		
17.	C (55)		
18.	D (63)		
19.	A (45)		
20.	D (53)		
21.	B (90)		
22.	B (57)		
23.	C (44)		
24.	C (72)		
25.	A (69)		

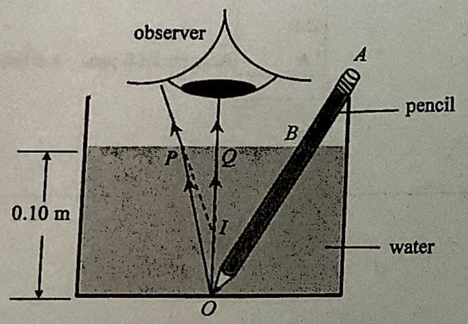
Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.

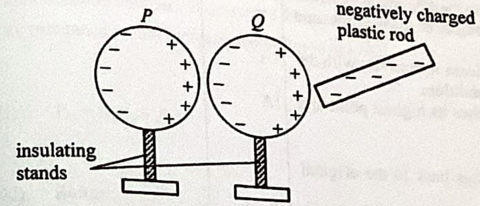
Paper 1 Section B

Solution	Marks	Remarks
1. (a) conduction / radiation	1A	
	1	
(b) Will not, as the silvery surface of aluminum foil is a poor radiation absorber / good radiation reflector.	1A+1A	
	2	
(c) (i) The water droplets come from the moisture / water vapour in the air (surroundings).	1A	
	1	
(ii) $E = (0.40 \times 10^{-3})(2.26 \times 10^{6})$	1M	
$= 904$ J	1A	
	2	
2. (a) (i) $E_K = \frac{1}{2}\left(6.63\times10^{-26}\right)(500)^2$	1M	
$= 8.2875 \times 10^{-21}$ J $\approx 8.29 \times 10^{-21}$ J	1A	Accept: $(8.29 \sim 8.30) \times 10^{-21}$ J
	2	
(ii) $E_K = \frac{3RT_0}{2N_A}$		
$T_0 = \frac{2}{3}\left(\frac{8.29\times10^{-21}}{8.31}\right)(6.02\times10^{23})$	1M	e.c.f. from (a)(i)
$= 400.247$ (K) ≈ 400 (K)	1A	
	2	
(b) As temperature remains at T_0, E_K remains unchanged / $c_{r.m.s.}$ depends on temperature,	1A	
so root-mean-square speed $c_{r.m.s.}$ remains unchanged.	1A	
	2	

Solution	Marks	Remarks
3. (a) By $Fs = \frac{1}{2}mv^2$,	1M	Or $v^2 = u^2 + 2as$ and $F = ma$
$0.30 \times 0.75 = \frac{1}{2}(0.20)\,v^2$		$v^2 = 0^2 + 2(\frac{0.30}{0.20})(0.75)$
$v = 1.5\ \mathrm{m\,s^{-1}}$	1A	
	2	
(b) 	2A	Accept: normal force, gravity
	2	
(c) Height $= \frac{1}{2}gt^2 = \frac{1}{2}(9.81)(0.35)^2$	1M	
$= 0.6008625\ \mathrm{m} \approx 0.601\ \mathrm{m}$	1A	Accept: 0.60 m ~ 0.613 m
	2	
4. (a) (i) $F = m\omega^2 r = 0.020 \times 6^2 \times 0.50$	1M	
$= 0.36\ \mathrm{N}$	1A	
	2	
(ii) Top view from A 	1A	
	1	
(b) (i) same angular speed	1A	
	1	
(ii) different / smaller magnitude of centripetal acceleration ($a_Q < a_P$)	1A	
as Q takes a different / smaller radius ($r_Q < r_P$)	1A	
	2	

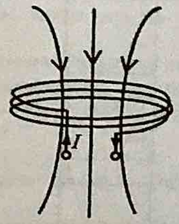
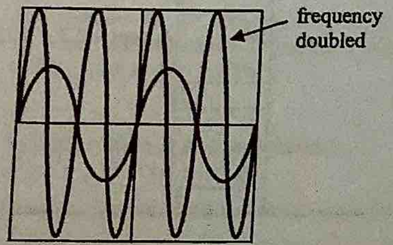
Solution	Marks	Remarks
5. (a) 	2A	
	2	
(b) (i) P / R / T	1A	
	1	
(ii) R	1A	
	1	
6. (a) Apply $d\sin\theta = m\lambda$, where θ is the deviation angle of the diffracted beam, m is the order of diffraction maximum.		
$\tan\theta = \frac{x/2}{L} \Rightarrow \theta = 24.702430°$ or $\sin\theta = \frac{x/2}{\sqrt{L^2+(x/2)^2}} = 0.417906$	1M	
$d = \frac{\lambda}{\sin\theta} = \frac{650 \times 10^{-9}}{0.418}$	1M	
$= 1.555375 \times 10^{-6}\ \mathrm{m} \approx 1.56\ \mu\mathrm{m}$	1A	Accept: 1.56 μm ~ 1.6 μm
	3	
(b) x will decrease	1A	
as λ decreases, $\sin\theta$ and θ will decrease.	1A	
	2	

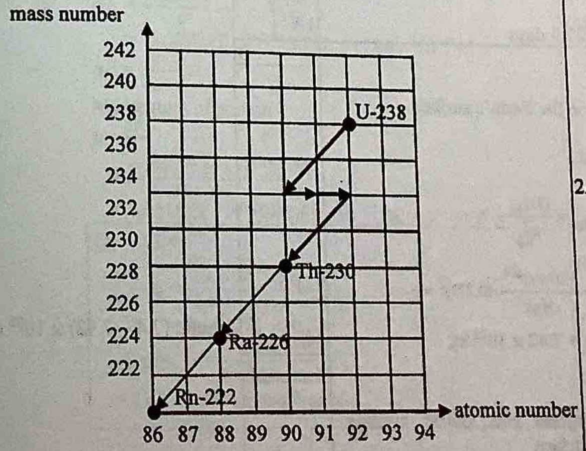
	Solution	Marks	Remarks
7. (a)	The speed of sound increases (linearly) with air temperature. Or The higher the air temperature, the greater is the speed of sound.	1A 1	
(b)	The air near the ground is cooler while the air layers higher above are relatively warmer, the sound wave bends downward (towards the normal) as it travels slower when going from a higher temperature (upper) layer into a low temperature (lower) layer and vice versa, i.e. refraction occurs.	1A 1A 2	
(c) (i)	Speed ratio $\frac{3.00\times10^8}{337} = 8.90208 \times 10^5 \approx 8.90 \times 10^5$	1A 1	
(ii)	The distance is given by 337×3.0 $= 1011$ m	1M 1A 2	e.c.f. from (c)(i) using incorrect sound speed Accept: 1010 m ~ 1011 m
8. (a)		1A 1M 2	1M for image I formed by the two refracted rays.
(b)	$1.33 = \frac{\sin r}{\sin 1.5^\circ}$ $r = 1.995175^\circ \approx 2.00^\circ$	1M 1A 2	
(c)	$\frac{h_1}{h} = \frac{\tan 1.5^\circ}{\tan 2.00^\circ} = 0.751681$ (or $\tan 1.5^\circ = \frac{PQ}{0.10}$ & $\tan 2^\circ = \frac{PQ}{h_1}$) $\Rightarrow h_1 \approx 0.075$ m (i.e. 7.5 cm)	1M 1A 2	e.c.f. from (b), explicit step / method shown Accept: $\frac{\text{real depth}}{\text{apparent depth}} = \frac{h}{h_1} = n$

	Solution	Marks	Remarks
9. (a)		2A 2	
(b)	No, it remains unchanged as charging is through induction (without any contact or transfer of charges).	1A+1A 2	
(c)	Hold / bring the unknown charged rod (assume positive) near sphere P, which carries positive charges, without touching it. If P is repelled by the rod, the rod should carry positive charges. And / Or If P is attracted by the rod, the rod should carry negative charges.	1A 1M 2	1M for the correct procedure to identify the polarity of the charged rod.

Solution	Marks	Remarks
10. (a) 1. Use the protractor to measure or mark a specific angle at which the ball is released. Make sure the angle is measurable and recorded.	1A	
2. Hold the ball at the marked angle and release it from rest with the string taut, allowing it to swing like a pendulum.	1A	
3. Measure the angle at which the ball reaches its highest point and record the value. Or Observe the angle at which the ball swings back to the original releasing position.	1A	
4. Compare the measurements of the ball's initial angle of release to the angle it reaches on the opposite side of the swing. (The angles equal implies total mechanical energy is conserved.)	1A	
	4	
(b) (i) (I) The tension forces are vertical / perpendicular to the direction of collision, the condition of no external forces along the colliding / horizontal direction is still fulfilled, the law can be applied. Or The tensions in the string acting on the spheres are balanced by the weights of the spheres so that the net force acting on the system is zero.	1A	
	1	
(II) By conservation of total momentum, v_E is $2 \times 0.50 = 1.0\ \text{m s}^{-1}$	1A	
However, the final total kinetic energy would then be $\frac{1}{2}(0.020)(1.0)^2 = 0.01\,J > \frac{1}{2}(2\times0.020)(0.50)^2 = 5\times10^{-3} = 0.005\,J$	1M	
which is greater than the total kinetic energy before collision, thus it is not possible.	1A	
	3	
(ii) Not perfectly elastic as some kinetic energy is lost as sound / thermal energy, the total kinetic energy is not conserved.	1A+1A	
	2	

Solution	Marks	Remarks
11. (a) As the foil becomes longer / l increases while its cross-sectional area becomes smaller / A decreases due to decrease in width w,	1A	
its resistance would increase according to $R = \frac{\rho l}{A}$.	1A	
	2	
(b) (i) $V_{in} = I_1(R_1 + R_2)$	1A	
	1	
(ii) Before: $\frac{V_{out}}{V_{in}} = \frac{R_4}{R_3+R_4} - \frac{R_2}{R_1+R_2}$ $= \frac{500}{470+500} - \frac{470}{470+470} = 0.0154639$	1M	
After: $\frac{V_{out}}{V_{in}} = \frac{R_4}{R_3+R_4} - \frac{R_2}{R_1+R_2}$ $= \frac{501}{470+501} - \frac{470}{470+470} = 0.0159629$ Thus $\frac{V_{out}}{V_{in}}$ increases $3.22687\% \approx 3.23\%$.	1A	Accept $\pm(3.2 \sim 3.23)\%$ as the change
	2	
(iii) (I) crack ①	1A	
(II) along AB	1A	
	2	

Solution	Marks	Remarks
12. (a) 	2A	1A for correct direction (also accept field lines pointing upwards for observers with different perception of current direction) 1A for correct field pattern
	2	
(b) (i) The a.c. flowing in transmitter coil T generates a changing magnetic field,	1A	
thus by electromagnetic induction an induced e.m.f. is produced in receiver coil R to oppose the changing magnetic flux experienced by it.	1A	
	2	
(ii) CRO display 	2A	1A for correct frequency 1A for correct amplitude
	2	
(c) If the back cover is metallic, eddy currents will be produced (by induction),	1A	
loss of energy / heating effect results / magnetic field / flux is blocked by the metal case and thus making wireless charging impossible. <u>Or</u> Non-metallic materials such as glass are insulators, and no eddy currents are produced. As a result, energy loss / heating effect will be minimized / the magnetic field can pass through the back cover easily.	1A	
	2	

Solution	Marks	Remarks
13. (a) (i) $k = \frac{\ln 2}{t_{½}}$ $= \frac{\ln 2}{3.82 \times 24 \times 3600}$	1M	
$= 2.1001405 \times 10^{-6}\ \text{s}^{-1} \approx 2.10 \times 10^{-6}\ (\text{s}^{-1})$	1A	
	2	
(ii) $A = kN$ $N = \frac{48}{2.10 \times 10^{-6}}$	1M	e.c.f. from (a)(i)
$= 2.285561 \times 10^{7} \approx 2.29 \times 10^{7}$	1A	Accept: $(2.28 \sim 2.3) \times 10^{7}$
	2	
(iii) As radon is a gas that can be inhaled into the lungs of human,	1A	
the relatively strong ionizing power of α particles emitted by decaying radon / radioactive gas might affect the organs / cells nearby.	1A	
	2	
(b) 	2A	
	2	

Paper 2

Section A : Astronomy and Space Science

1. A (59%)	2. B (51%)	3. D (32%)	4. A (36%)
5. C (36%)	6. C (48%)	7. B (41%)	8. D (67%)

Solution	Marks	Remarks
1. (a) (i) Assuming a circular orbit, the orbital velocity $v=\frac{2\pi r}{T}$.		
As $\frac{GM_E M_M}{r^2}=\frac{M_M v^2}{r}$	1M	
$T^2=\frac{4\pi^2 r^3}{GM_E}=\frac{4\pi^2(384400\times10^3)^3}{(6.67\times10^{-11})(5.97\times10^{24})}$	1M	
$\Rightarrow T=2.373039\times10^6$ s $=27.465727$ days ($\approx$ 27 to 28 days)	1A	Accept: $(2.33\sim2.38)\times10^6$ s
Or $\frac{GM_E}{r^2}=\frac{v^2}{r}$	1M	
$v=\sqrt{\frac{GM_E}{r}}=1017.7905\text{ m s}^{-1}\approx1018\text{ m s}^{-1}$		
$T=\frac{2\pi r}{v}=\frac{2\pi(384400\times10^3)}{1018}$	1M	
$=2.37\times10^6$ s $\approx$ 27.5 days	1A	
	3	
(ii) Gravitational acceleration on the Earth's surface $g_E=\frac{GM_E}{R_E^2}$	1M	
while that on the Moon is $g_M=\frac{GM_M}{R_M^2}$.		
Thus $\frac{g_E}{g_M}=\left(\frac{M_E}{M_M}\right)\cdot\left(\frac{R_M}{R_E}\right)^2=\frac{5.97\times10^{24}}{M_M}\cdot(0.273)^2=6$	1M	
$\Rightarrow M_M=7.415636\times10^{22}\text{ kg}\approx7.42\times10^{22}$ kg	1A	Accept: $(7.4\sim7.42)\times10^{22}$ kg
	3	
(b) (i) Let T_H and T_L be the highest and lowest average temperature on the Moon's surface, $L_H=\sigma(4\pi R_M^2)T_H^4$ $L_L=\sigma(4\pi R_M^2)T_L^4$	1M	
$\therefore\ \frac{I_H}{I_L}=\frac{L_H}{L_L}=\left(\frac{T_H}{T_L}\right)^4=\left(\frac{390}{95}\right)^4=284.030\approx284$	1A	
	2	
(ii) Assumption: Power / energy received / incident on the Moon is equal to power / energy radiated by the Moon.	1A	
	1	
(c) Accept any ONE: · No atmosphere to blur the images · No atmosphere to block / absorb various types of electromagnetic radiation · No atmosphere to scatter sunlight · No light pollution from artificial light · Observation can be made during day time or any time	1A	
	1	

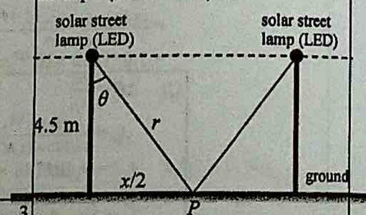
Section B : Atomic World

1. C (60%)	2. A (47%)	3. A (65%)	4. D (62%)
5. C (48%)	6. B (34%)	7. B (56%)	8. D (63%)

Solution	Marks	Remarks
2. (a) In Rutherford's model, the electron emits electromagnetic waves and thus loses energy when it accelerates (orbits around the nucleus).	1A 1A	
	2	
(b) (i) absorption (line) spectrum	1A	
	1	
(ii) In Bohr's model, the electron can only orbit around the nucleus in certain allowed orbits and therefore having discrete energy levels.	1A	
Only certain specific / discrete / quantized energies which equal the differences between these energy levels can be absorbed to produce the line spectrum.	1A	
	2	
(c) (i) $\Delta E=-\frac{13.6\text{ eV}}{6^2}-\left(-\frac{13.6\text{ eV}}{1^2}\right)$ $=13.222222\text{ eV}=13.222\times(1.60\times10^{-19})$ J	1M	
$\Delta E=\frac{hc}{\lambda_p}=pc$ Momentum of photon $p=\frac{\Delta E}{c}$ $=\frac{13.222\times(1.60\times10^{-19})}{3.00\times10^8}$	1M	
$=7.051852\times10^{-27}\approx7.05\times10^{-27}$ kg m s^{-1} or N s	1A	Accept: $(7.03\sim7.1)\times10^{-27}$ kg m s^{-1}
Or $\Delta E=\frac{hc}{\lambda_p}$ $\lambda_p=\frac{6.63\times10^{-34}\times3.00\times10^8}{13.222\times(1.60\times10^{-19})}$ $=9.401786\times10^{-8}$ m	1M	
$p=\frac{h}{\lambda_p}=\frac{6.63\times10^{-34}}{9.401786\times10^{-8}}$	1M	
$=7.05\times10^{-27}$ kg m s^{-1} or N s	1A	
	3	
(c) (ii) $E_1=-\frac{13.6\text{ eV}}{1^2}=-\frac{K}{r_1}$ $E_6=-\frac{13.6\text{ eV}}{6^2}=-\frac{K}{r_6}$	1M	
$\Rightarrow r_6=6^2(r_1)=36\,r_1$	1A	
	2	

Section C : Energy and Use of Energy

1. B (82%)	2. C (60%)	3. C (41%)	4. B (74%)
5. A (54%)	6. D (40%)	7. A (62%)	8. D (39%)

Solution	Marks	Remarks
3. (a) (solar energy →) electrical energy → chemical energy	1A	
	1	
(b) (i) $E = Pt$ $405 = (980 \times 0.111 \times 0.25)\, t$ $t = 14.892443 \approx 14.9$ (hours)	1M 1A	Accept: 14.9 ~ 15 (hours)
	2	
(ii) $\frac{405 \times 0.8}{30}$ $= 10.8$ (hours)	1M 1A	
	2	
(c) (i) $\frac{5160}{30} = 172$ (lm W^{-1})	1M/1A	
	1	
(ii) $2 \times \frac{5160}{4\pi(4.5)^2} \times \cos^3\theta = 10$ $\cos\theta = 0.627073$ $\theta = 51.165466°$	1M	$\cos\theta = \frac{4.5}{\sqrt{(x/2)^2 + 4.5^2}}$
$\tan\theta = \frac{x/2}{4.5}$ $x = 11.179937$ m ≈ 11.2 m	1M 1A	Accept: (11.1 ~ 11.3) m
Or $2 \times \frac{5160}{4\pi r^2} \times \frac{4.5}{r} = 10$ $r^3 = 369.558$ $r = 7.176193$ m $\frac{x}{2} = \sqrt{r^2 - 4.5^2}$ $x = 11.2$ m	1M 1M 1A	
	3	
(d) The output voltage of the solar panel is d.c. LED lamps work on d.c. while (some) compact fluorescent lamps (CFL) work on a.c. / may need high operating voltage. Or LED has no toxic materials / CFL contains mercury (poses disposal issue) Or LED has a longer lifetime / replacement of LED is less frequent	1A	
	1	

Section D : Medical Physics

1. B (50%)	2. A (65%)	3. C (58%)	4. C (59%)
5. D (53%)	6. D (48%)	7. A (37%)	8. B (43%)

Solution	Marks	Remarks
4. (a) *Penetrating power and its implication:* γ rays have no (rest) mass and are pure energy with highest penetrating power / penetrate longest (largest) distance in body than α and β particles; pass through body / can be detected using Gamma cameras outside the body.	1A	
Ionizing power and its implication: γ rays have least / smallest ionizing power, thus can be used safely as they mostly just pass through the body and cause less ionization damage / less harmful in our cells.	1A	
	2	
(b) (i) The physical half-life $T_{\frac{1}{2}}$ of ^{99m}Tc is 6 (hours).	1A	
	1	
(ii) Time interval t is 2 hours and A_0 is 550 MBq/mL, thus the activity A at 11:00 a.m. is $A = A_0 e^{-t\left(\frac{\ln 2}{T_{\frac{1}{2}}}\right)}$ $= A_0 e^{\frac{-2\ln 2}{6}} = 550 \times 0.7937$ $\therefore A = 436.5$ $(\frac{\text{MBq}}{\text{mL}})$ The volume required $= \frac{600}{436.5}$ $= 1.37446 \approx 1.37$ (mL) Alternatively: $600 = (550 \times V)\left(\frac{1}{2}\right)^{2/6}$ $V = 1.37$ (mL)	 1M 1M 1A	e.c.f. from (b)(i) Or $A = A_0 e^{-t\left(\frac{\ln 2}{T_{\frac{1}{2}}}\right)} = A_0 e^{-t(0.1155)}$ $600 = A_0 e^{\frac{-2\ln 2}{6}} = A_0 \times 0.7937$ $\therefore A_0 = 755.953$ $(\frac{\text{MBq}}{\text{mL}})$ The volume required $= \frac{A_0}{550} = \frac{756}{550} = 1.37446 \approx 1.37$ (mL)
Or From the graph: $A = 550 \times 0.78$ to 550×0.80 $= 429$ to 440 $(\frac{\text{MBq}}{\text{mL}})$ The volume required $= \frac{600}{440}$ to $\frac{600}{429}$ $= 1.36$ to 1.40 (mL)	1M 1M 1A	Or Relative activity: 0.78 to 0.80 $A_0 = \frac{600}{0.80}$ to $\frac{600}{0.78}$ $= 750$ to 769 $(\frac{\text{MBq}}{\text{mL}})$ The volume required = 1.36 to 1.40 (mL)
	3	
(iii) The dosage left after 24 hours is $A = 600 \times e^{-24 \times \frac{\ln 2}{4.8}} = 600 \times e^{-24 \times 0.1444}$ $= 600 \times 0.0313 = 18.75$ (MBq) i.e. $\frac{18.75}{600} \times 100\% = 3.125\%$	 1M 1A	$\left(\frac{1}{2}\right)^{24/4.8} = 0.03125 = 3.125\%$
	2	
(iv) Biological elimination / metabolism / diffusion / excretion of radioactive substances (drugs) in body accounts for the difference. Or The effective decay of radioactive substances in body depends on biological decay and physical decay.	1A	
Thus, the actual decay / disappearance / drop / decrease of activity (percentage dosage) in body is more than the relative activity curve (physical decay) alone.	1A	
	2	

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)

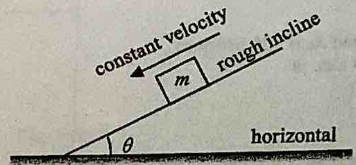
Section A consisted of 33 multiple-choice questions and the mean score was 19. Items where candidates' performance was typically weaker will be presented below with mean percentage statistics.

3. The best vacuum attained in the laboratory has a pressure of about 10^{-8} Pa. Estimate the order of magnitude of the number of air molecules in 1 cm³ of such 'vacuum' at room temperature.

A.	10^4	(13%)
*B.	10^6	(49%)
C.	10^8	(21%)
D.	10^{12}	(17%)

About half of the candidates were able to obtain the correct estimation of the order of magnitude.

5.

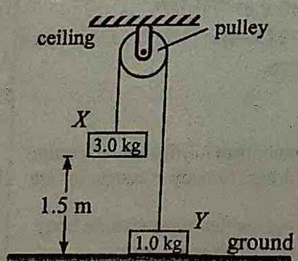


A block of mass m slides down along a fixed rough incline with constant velocity as shown. The incline makes an angle θ with the horizontal. What is the magnitude of the force exerted on the incline by the block ?

A.	zero	(7%)
*B.	mg	(23%)
C.	$mg\sin\theta$	(27%)
D.	$mg\cos\theta$	(43%)

Candidates choosing option D did not realise that $mg\cos\theta$, which is perpendicular to the incline, is just a component of the force required.

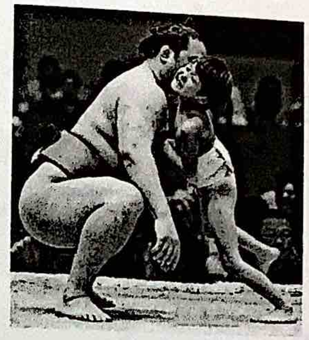
8. Block X and Y of mass 3.0 kg and 1.0 kg respectively are connected by a light inextensible string passing over a smooth light pulley fixed to the ceiling as shown. The blocks are released from rest. Find the time taken for block X to reach the ground. Neglect air resistance.

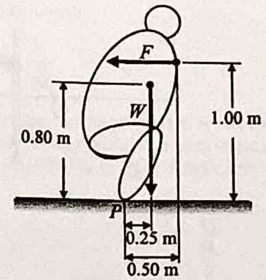


A.	0.55 s	(29%)
B.	0.64 s	(19%)
C.	0.68 s	(14%)
*D.	0.78 s	(38%)

Nearly 30% of the candidates wrongly thought that block X underwent free falling and chose option A.

10. A child tries to push a 150 kg (sumo) wrestler in order to topple him backwards in a game. The simplified diagram indicates the weight W of the wrestler and the horizontal pushing force F acting on the wrestler by the child. P is the wrestler's contact point on the ground.



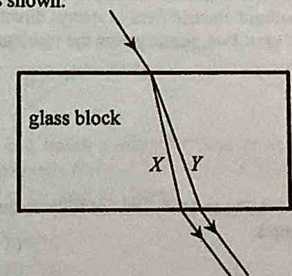


Find the minimum value of F required.

*A.	368 N	(33%)
B.	736 N	(31%)
C.	1177 N	(23%)
D.	2354 N	(13%)

About one-third of the candidates were able to correctly manipulate the two moments of force in this item.

14. A light beam consisting of monochromatic light beam X and Y is incident on a rectangular glass block. It splits into two beams as shown.



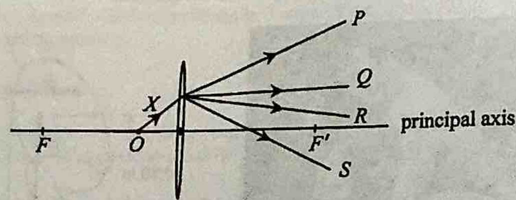
Which of the following comparisons of beam X and Y is/are correct ?

(1) X has a higher frequency.
(2) X has a larger speed in glass.
(3) In the glass block, the critical angle for X is greater.

*A.	(1) only	(44%)
B.	(3) only	(30%)
C.	(1) and (2) only	(13%)
D.	(2) and (3) only	(13%)

Candidates choosing options C and D did not realise that the speed of beam X in glass is smaller than that of beam Y.

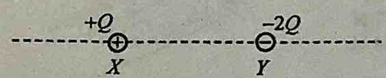
19. X is a light ray from an object O placed on the principal axis of a convex lens as shown. F and F' are the foci of the lens. Which light ray best represents the emergent ray ?



*A.	P	(45%)
B.	Q	(18%)
C.	R	(18%)
D.	S	(19%)

Less than half of the candidates answered correctly.

23. Charges $+Q$ and $-2Q$ are fixed at X and Y as shown.



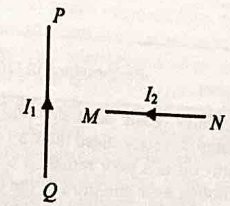
Which description(s) about the electric field along the dotted line is/are correct ?

(1) Between X and Y, the respective electric fields due to the two charges are in the same direction.
(2) To the right of Y, the resultant electric field is always directed to the left.
(3) On the dotted line, there exist two points where the resultant electric field is zero.

A.	(2) only	(26%)
B.	(3) only	(13%)
*C.	(1) and (2) only	(44%)
D.	(1) and (3) only	(17%)

Candidates choosing options A and B suggest they did not fully understand the electric field patterns due to positive and negative point charges.

26.



PQ in the figure is a section of a fixed long straight wire carrying a current I_1. MN is a section of another long straight wire carrying a current I_2. MN is perpendicular to PQ and both wires are in the same plane. What is the direction of the magnetic force acting on MN due to PQ ? Neglect the effects of the Earth's magnetic field.

A. pointing out of the paper (15%)

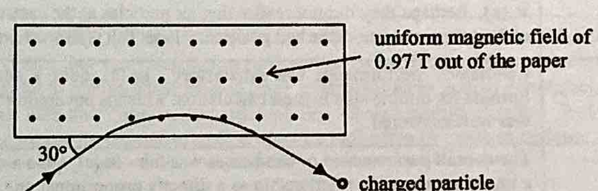
*B.  (49%)

C. pointing into the paper (27%)

D.  (9%)

Candidates choosing option C mistook the direction of the magnetic field near wire MN as the direction of the magnetic force acting on the wire.

29.



A charged particle enters and leaves a magnetic field of uniform flux density 0.97 T along the path as shown. It experiences a magnetic force of 5.9×10^{-12} N within the magnetic field. Given that the speed of the particle is 1.9×10^{7} m s^{-1}, find its charge.

A.	-3.2×10^{-19} C	(17%)
*B.	$+3.2 \times 10^{-19}$ C	(44%)
C.	-6.4×10^{-19} C	(12%)
D.	$+6.4 \times 10^{-19}$ C	(27%)

Less than half of the candidates fully understood the mutually perpendicular spatial relationship between magnetic field, velocity of charged particle and the magnetic force.

31. Which statements about domestic electricity are correct ?

(1) All fuses should be installed in the live wire.
(2) An electrical appliance can work even without an earth wire.
(3) An electrical appliance having a fuse in it can protect people from getting an electric shock.

*A.	(1) and (2) only	(45%)
B.	(1) and (3) only	(8%)
C.	(2) and (3) only	(7%)
D.	(1), (2) and (3)	(40%)

More than half of the candidates mixed up the functions of fuse and earthing.

Section B (conventional questions)

Question Number	Performance in General
1	This question tested candidates' basic understanding of heat transfer. The performance was satisfactory. Most candidates correctly stated the way of heat transfer in (a). However, not many knew that as the aluminum foil is a poor radiation absorber, it would not speed up the rate of temperature increase. Although over one-third of the candidates could not identify the source of the water droplets in (c)(i), most were able to answer (c)(ii) correctly.
2	Candidates' performance was satisfactory. The calculations in (a)(i)(ii) were straightforward and many candidates answered correctly. A few candidates wrongly added 273 K to or subtracted 273 K from the absolute temperature T_0 calculated. In (b), quite a number of the candidates did not know that $c_{r.m.s.}$ depends on the temperature. Some tried to explain by using the equation $c_{r.m.s.} = \sqrt{\frac{3pV}{Nm}}$ but wrongly held that only N decreased and p remained the same.
3	The overall performance of candidates was good. In drawing the force diagram in (b), the less able candidates wrongly included the horizontal applied force, which had already been removed. In (c), a few candidates did not know that the initial vertical velocity of the block is zero.
4	Candidates' performance was good. Most were able to find the centripetal force and correctly indicated the direction of motion of P in (a)(i)(ii). Although in (b)(i) most candidates identified P and Q having the same angular speed, some candidates wrongly held that P and Q had the same radius for their respective circular motions in (b)(ii).
5	This question examined candidates' basic understanding of longitudinal waves. The overall performance was fair. Not many were able to sketch the displacement-distance graph correctly in (a). Perhaps they did not realise that air particles at the centre of compression / rarefaction are at their respective undisturbed positions. Parts (b)(i)(ii) were well answered.
6	Candidates' performance was satisfactory. In (a), quite a number of the candidates used the formula for double slits in their calculation, which is not applicable to diffraction grating. Part (b) was well answered.
7	The overall performance of candidates was fair. In (a), quite a number of the candidates mistook a linearly increasing relationship as a directly proportional one. Not many were able to account for the refraction of sound waves in the situation described in (b). Some wrongly thought that the air layer higher above the ground was cooler, which was in fact the contrary. Most candidates correctly obtained the speed ratio of light and sound in (c)(i). Some of them performed complicated calculations in (c)(ii) as they failed to ignore the negligible time of travel for light.
8	This question tested candidates' understanding of wave motion in the context of apparent depth. The performance was fair. Not many were able to complete the two light rays and label the image correctly in (a). In (b), the less able candidates mistook the angle 1.5° for the light ray in water as that for the refracted ray in air. Candidates did poorly in (c) as this part required the application of trigonometry and ratios.
9	Candidates' performance was satisfactory. Most knew that there was separation of positive and negative charges on both spheres in (a). However, some did not pay attention to the balance of opposite charges on each sphere. In (b), a few candidates wrongly thought that the plastic rod would not lose charge as it is an insulator. Although some candidates failed to identify the sign of charges carried by sphere P, most were able to describe the procedure for finding the unknown polarity of another charged rod in (c).
10	Candidates did well in (a) which asked for how to demonstrate the conservation of energy. A few of them forgot to point out the measurements to be made. Part (b) examined candidates' knowledge and understanding of momentum in the context of Newton's cradle. The overall performance was fair. In (b)(i)(I), some candidates mixed up the conservation of linear momentum and the conservation of mechanical energy and stated 'no work done by the tensions' as the explanation. In explaining why the case was impossible in (b)(i)(II), a few candidates did not calculate the initial and final kinetic energy of the system or failed to find the correct values. Quite a number of the candidates failed to account for the loss in kinetic energy in the repeated collisions in (b)(ii).
11	This question tested candidates' understanding of simple circuits in the context of a kind of deformation sensors known as strain gauge. The overall performance was satisfactory. Candidates knew that the metal foil's resistance increases in (a), however, many overlooked that the cross-sectional area A of the foil decreased when the foil was stretched. (b)(i) was well answered while some candidates were not careful enough in substituting the resistance values into the given equation in (b)(ii). Less than half of the candidates made a correct deduction in (b)(iii)(II).
12	Candidates did poorly in this question. Most knew the direction of the magnetic field in (a) but failed to sketch precisely the field pattern. In explaining the electromagnetic induction between the transmitting and receiving coils in (b)(i), quite a number of the candidates failed to spell out explicitly that the transmitting coil produced a changing magnetic field. In (b)(ii), very few candidates realised that the amplitude of the voltage induced in coil R would double when the frequency was doubled. In (c), not many candidates realised that the use of non-metallic back covers for mobile phones was to facilitate the passage of magnetic field between the transmitting and receiving coils. Some wrongly thought that 'electric shock may occur as metals are conductors' or 'current may flow through the metallic cover and cause heating effect'.
13	Candidates' performance was satisfactory. Many obtained the correct numerical answers in (a)(i)(ii). In (a)(iii), not many candidates realised that radon, being a gas and an α-emitter, would be harmful to human when inhaled since α particles have limited penetrating power. A few wrongly held that it was the α particles being inhaled instead of radon. Part (b) was well answered except for the omission of arrows for indication by some candidates.

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	(a)(i)(ii) were well answered. Some less able candidates mistook the radius of the Earth or the Moon as the orbital radius of the Moon around the Earth. A few candidates wrongly used the gravitational potential energy to find the gravitational acceleration in (a)(ii). Although many candidates were able to find the solar intensity ratio in (b)(i) using Stefan's law, very few correctly stated the assumption of thermal equilibrium for the Moon in (b)(ii). In (c), not many fully understood the advantages of no atmosphere for astronomical observation.
2	64	In (a), many candidates knew that Rutherford's atomic model was unstable but some of them failed to explain concisely the way through which energy was lost. In (b)(i), half of the candidates were correct in stating the name of the kind of spectrum produced. Not many candidates managed to explain how this absorption line spectrum was produced in terms of the energy difference between energy levels. In finding the momentum of photons in (c)(i), some of their calculations employed the classical approach and this revealed candidates' misconception that photons were having mass. (c)(ii) was in general well answered.
3	86	Candidates' performance in (a) was fair. Some wrongly thought that thermal energy of the Sun was converted to electrical energy while a few omitted the chemical energy to be stored in the battery. Candidates did well in the calculations in (b)(i)(ii) as well as in (c)(i). Not many candidates obtained the correct answer in (c)(ii). Some made mistakes using Lambert's law while some calculations just included one street lamp instead of two. In (d), about one-third of the candidates understood why LED lamps were preferred to compact fluorescent lamps.
4	33	Candidates did well in (a). Most candidates gave appropriate reasons why gamma rays were chosen for radionuclide imaging. However, a few candidates had a misconception that gamma rays would not induce cancer because of its low ionization power. Part (b) tested candidates' basic understanding of exponential law of decay and its application in problem solving. (b)(i) was well answered. In (b)(ii), candidates were asked to estimate the volume of a radioactive solution of a prescribed activity for injection two hours later. Most candidates were able to find the answer either using the graph or by calculation. The less able ones had difficulties in using the decay equation. In (b)(iii), many candidates correctly obtained the dosage left after 24 hours. Their performance in (b)(iv) was poor. Not many of them understood that biological processes increase the overall rate of elimination of radioactive substances in the body, thus the effective decay of activity is more than the physical decay alone.

School-based Assessment

All school candidates sitting for HKDSE Physics have to participate in School-based Assessment (SBA). For the 2024 HKDSE examination, a streamlined assessment requirement was implemented for SBA to alleviate the pressure due to the COVID-19 pandemic on this specific cohort of students. As such, at least one mark for experiment (EXPT) and one mark for Investigative Study (IS) or an experiment with a detailed report (EXPT*) are required, which is less than the minimum requirement of three experiments for assessment in normal years.

9939 students from 438 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. 53.7% of schools fell into the 'within the expected range' category, with 28.5% of schools having marks slightly higher than expected, and 17.8% of schools having marks slightly lower than expected. This is encouraging as the data show 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. In general, the overall performance of candidates was satisfactory given that schools resumed face-to-face classes only from February 2023 onwards. The major observations for this year's SBA are:

1. Most schools opted for the write-up of a detailed report instead of an Investigative Study for SBA. The goal of a detailed report is to help students develop the knowledge and skills necessary to nurture their science process skills. In most of the reports, candidates were able to demonstrate their process skills. It was found that some teachers provided clear and concise written feedback in the reports which could enhance students' learning.

2. The design, format and tasks of experiments submitted for SBA were diverse. Most of the assignments were appropriate and relevant topics from the curriculum were selected. Based on the reports submitted by schools, the average number of experiments for assessment purposes was around four which was more than the streamlined minimum requirement of two experiments. Teachers selected a diverse coverage of topics. The most popular tasks were centripetal force in 'Mechanics', specific heat capacity in 'Heat and Gases', focal length and diffraction grating in 'Light', Ohm's law and internal resistance in 'Electricity and Magnetism'. It was encouraging to see that some teachers provided experiments such as emission spectrum of the Helium gas discharge tube, inverse-square law, illuminance and luminous flux that are related to the elective topics with extended questions to challenge higher-tier students.

3. Most reports submitted took the format of worksheets. Some worksheets were adopted from practical workbooks, while some were school-based designs with suitably adjusted level of difficulty. The worksheets required students to give a clear record of the data taken, working steps, calculations and the analysis. It was worth noting that some worksheets were designed in which procedures of the experiment were not given and with unknown results.

4. Most reports were satisfactorily marked. Besides indicating marks awarded to different parts of the reports, many teachers had provided assessment criteria and written feedback in the reports wherever appropriate in order to enhance assessment for learning. In addition, most teachers indicated clearly the mark allocation for practical skills (mostly ranging from 20% to 30%) and report writing skills in the reports. Some students were not able to plot data properly on graph paper while others recorded data with number of significant figures beyond the accuracy limit of the apparatus used.

5. In general, most tasks selected or devised were suitable for SBA as well as students' learning. However, there were a few cases in which the experiments chosen were either too trivial for assessment or the coverage of topics was too narrow with respect to a wide spectrum of physics concepts. The assessment aims and skills required were reiterated in the SBA Conference, and follow-up by respective DCs was conducted. Teachers are reminded to exercise professional judgment in selecting and devising tasks/worksheets, so that students' science process skills and competencies in report writing can be demonstrated through these tasks.

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 plagiarising 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.