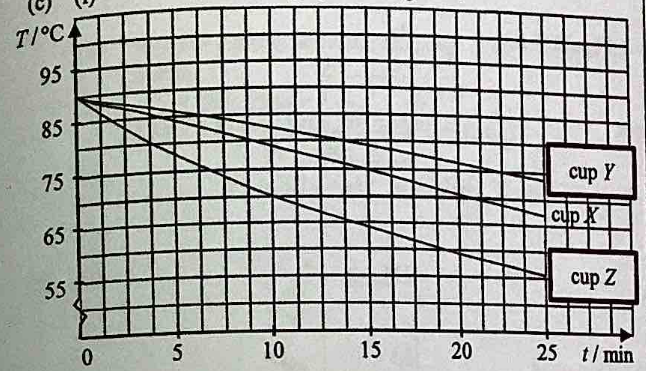
Paper 1 Section A

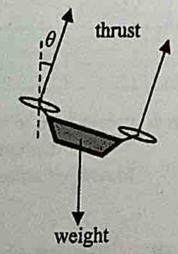
Question No.	Key	Question No.	Key
1.	A (76)	26.	B (65)
2.	B (54)	27.	A (61)
3.	D (80)	28.	C (26)
4.	C (56)	29.	B (34)
5.	A (51)	30.	A (45)
6.	B (47)	31.	C (63)
7.	B (84)	32.	A (50)
8.	B (49)	33.	C (83)
9.	D (61)		
10.	D (32)		
11.	A (46)		
12.	D (75)		
13.	C (67)		
14.	A (52)		
15.	B (70)		
16.	C (71)		
17.	D (67)		
18.	B (63)		
19.	C (55)		
20.	A (72)		
21.	C (44)		
22.	D (64)		
23.	C (24)		
24.	D (28)		
25.	D (54)		

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

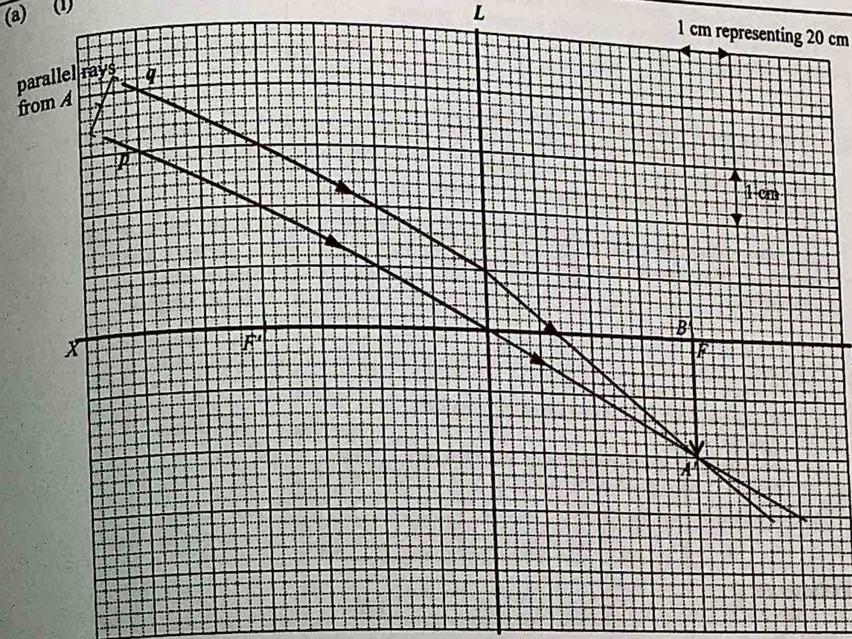
Paper 1 Section B

Solution	Marks	Remarks
1. (a) Fair test (otherwise the initial temperature would affect the result).	1A	
	1	
(b) Temperature difference between hot water and the surroundings (room temperature) decreases as time elapses.	1A	
Rate of energy loss / heat loss becomes smaller, hence rate of temperature drop is smaller and the curve becomes less steep.	1A	
	2	
(c) (i) The graphs of T against t 	1A	
	1	
(ii) Comparing to cup X as a control,	1A	
Cup Y: The shiny surface of aluminium foil is a poor emitter / good reflector of radiation (thus reduces heat lost to surroundings).	1A	
Cup Z: No lid allows convection through air / surroundings.	1A	
Or No lid enhances heat lost by evaporation / convection / contacting with air / surroundings.	1A	
	3	
(d) Polystyrene / foam plastic or foam / wood	1A	
	1	

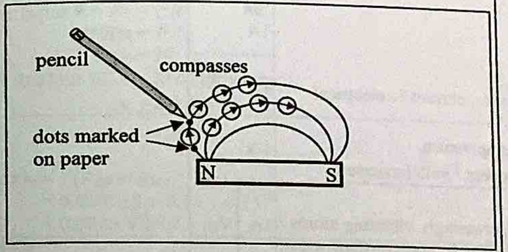
Solution	Marks	Remarks
2. (a) (i) (I) $pV = nRT$ $(1.0 \times 10^5)(6.0 \times 10^{-4}) = n(8.31)(300)$ $n = 0.0240674$	1M	
number of molecules $N = nN_A$ $= (0.0240674)(6.02 \times 10^{23})$ $= 1.448857 \times 10^{22} \approx 1.45 \times 10^{22}$	1A	
(II) average kinetic energy of gas molecules $E_K = \frac{3}{2}\left(\frac{R}{N_A}\right)T$ $= \frac{3}{2}\left(\frac{8.31}{6.02 \times 10^{23}}\right)(300)$	1M	
$= 6.211794 \times 10^{-21}\ \text{J} \approx 6.21 \times 10^{-21}\ \text{J}$	1A	
	4	
(ii) (I) N and E_K remain unchanged.	1A+1A	
	2	
(II) $E_K = \frac{1}{2}mc_{\text{r.m.s.}}^2$ $\frac{1}{2}m(600)^2 = \frac{1}{2}(\frac{1}{5}m)c_{\text{r.m.s.}}^2$	1M	
$\Rightarrow c_{\text{r.m.s.}} = \sqrt{5} \times 600$ $= 1341.6408\ \text{m s}^{-1} \approx 1340\ \text{m s}^{-1}$	1A	
	2	
(b) As gas C diffuses into the upper jar, its molecules collide with the air molecules and	1A	
thus describe a zig-zag path / not along a straight path.	1A	
	2	

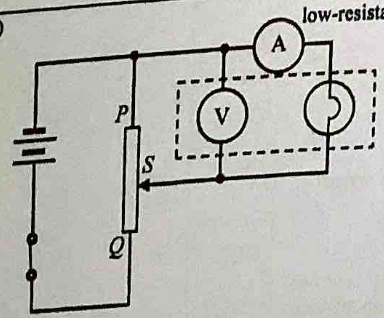
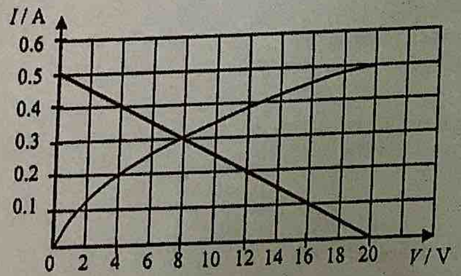
Solution	Marks	Remarks
3. (a) According to Newton's third law of motion, force on air streams and the thrust on the quadcopter are (equal and) opposite,	1A	
with magnitude given by F = rate of change of momentum (of air streams). Therefore the thrust (upward) on the quadcopter balances its weight for a certain speed of air streams.	1A	
	2	
(b) (i) Volume of air streams propelled in 1 s $V = 0.284\ v$	1M	
m_a = density × volume $= 1.20 \times 0.284\ v = 0.3408\ v$	1A	
	2	
(ii) Weight of quadcopter = rate of change of momentum of air streams $1.38\ g = m_a v - 0$ $1.38 \times 9.81 = (0.3408\ v) \times v$ (From (b)(i))	1M	
$v^2 = 39.723592$ $v = 6.302665\ \text{m s}^{-1} \approx 6.30\ \text{m s}^{-1}$	1A	For $g = 10\ \text{m s}^{-2}$, $v = 6.363408\ \text{m s}^{-1} \approx 6.36\ \text{m s}^{-1}$
	2	
(c) (i) 	2A	
	2	
(ii) centripetal force required $F = \frac{1.38 \times 15^2}{50}$	1M	
$= 6.21\ \text{N}$	1A	
	2	
(iii) Let T = total thrust on the quadcopter Vertical: $T\cos\theta = 1.38\ g$ ($g = 9.81\ \text{m s}^{-2}$) Horizontal: $T\sin\theta = 6.21\ \text{N}$ (From (c)(ii))	1M	Accept $\tan\theta = \frac{\text{centripetal force}}{\text{weight}}$
On solving the two equations, $\tan\theta = 0.458716$ $\theta = 24.641662° \approx 24.6°$	1A	For $g = 10\ \text{m s}^{-2}$, $\tan\theta = 0.45$ $\theta = 24.227745° \approx 24.2°$
	2	

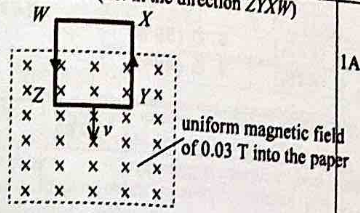
Solution	Marks	Remarks
4. (a) $\frac{1}{2}mv^2 = mgh$	1M	
$= (50)(9.81)(1.5)$ $= 735.75\text{ J} \approx 736\text{ J}$	1A	For $g = 10\text{ m s}^{-2}$, K.E. = 750 J
	2	
(b) (i) Kinetic energy and potential energy (of the athlete) change to elastic potential energy (of the trampoline).	2A	
	2	
(ii) $\bar{F}d = mgh + mgd$ [Or $\bar{F}d = \frac{1}{2}mv^2 + mgd$]	1M	
$\bar{F} = \frac{50(9.81)(1.5+0.40)}{0.40}$ $= 1839.375 + 490.5$ $= 2329.875\text{ N} \approx 2330\text{ N}$	1A	For $g = 10\text{ m s}^{-2}$, $\bar{F} = 2375\text{ N}$
Or $\bar{F} = \frac{1}{0.40}[735.75 + (50)(9.81)(0.40)]$	1M	
$\approx 2330\text{ N}$	1A	
	2	

Solution	Marks	Remarks
5. (a) (i) 		
refracted rays of p, q correctly drawn and	1A	
A' correctly marked.	1A	
image $A'B'$ correctly marked.	1A	
	3	
(ii) Image $A'B'$ of a distant object, say, a building is real and therefore it can be captured	1A	
by a screen (placed at the focal plane).	1A	
	2	
(b) (i) Ratio by similar triangles, $\frac{\text{height of } AB}{\text{object distance}} = \frac{\text{height of } A'B'}{\text{focal length / image distance}}$ $= \frac{2}{4\times 20} = \frac{1}{40}$	1M	Accept height of image $A'B'$: 1.8 cm ~ 2.2 cm
$= 0.025$	1A	
	2	
(ii) $\frac{\text{height of } AB}{\text{object distance}} = \frac{1}{40} = 0.025$ Height of $AB = 0.025 \times 200 = 5\text{ m}$	1A	
	1	

Solution	Marks	Remarks
6. (a) Sound waves having the same frequency / wavelength and a constant phase difference (or always in phase / in opposite phase) are coherent.	1A 1	
(b) (i) When the sound waves from A and B meet at various positions along OY, interference occurs. At positions where the two waves are in phase, constructive interference occurs and gives maximum (loudness). At positions where the two waves are in opposite phase, destructive interference occurs and gives minimum (loudness).	1A 1A 2	
(ii) Any ONE: • due to background noise • due to reflection of unwanted sound from the wall, floor etc. • the intensity of sound waves from A and B reaching P are NOT equal as $AP < BP$ therefore cancellation is incomplete.	1A 1	
(c) Path difference at Q $3\lambda/2 = 2.58 - 2.17$ $= 0.41$ m $\therefore\ \lambda = 0.27333333 \text{ m} \approx 0.273 \text{ m}$ $v = f\lambda$ $= (1200)(0.273)$ $= 328 \text{ m s}^{-1}$	1M 1A 2	Accept 327.6 m s^{-1} to 328 m s^{-1}
(d) Path difference Δ at any position along OY from A and B is less than AB (i.e. $\Delta = n\lambda < AB$) max. $\Delta = 0.80 \text{ m} = \frac{0.8}{0.273}\lambda \approx 2.93\lambda$ i.e. max. $\Delta < 3\lambda$ As path difference cannot be equal to $3\lambda, 4\lambda, \cdots$, therefore no more maximum beyond R.	1M 1A 2	
(e) increases	1A 1	

Solution	Marks	Remarks
7. (a) (i) A: south pole (S) B: south pole (S)	1A 1	
(ii) (Towards) bottom / downwards	1A 1	
(iii) Iron filings come into physical contact with the magnet will never come off / are difficult to get rid of.	1A 1	
(b) (i) Successively place the compasses on the paper near one pole (say N) of the magnet such that the tip of each compass needle follows / lines up with the tail of the compass ahead. Diagram  Denote the tip and tail (of each compass) with dots on the paper using the pencil <u>or</u> remove the compasses one by one and trace the (direction of) field line. Draw / sketch a smooth curve representing a field line by joining up the series of dots/segments going from one pole to the other. Repeat the above process by starting from different points around the magnet to get another/several field line(s).	1A 1A 1A 1A 1A 5	
(ii) Any ONE: • Compass is sensitive enough to explore very weak magnetic field such as the Earth's field. • The drawing can show the direction of the field lines / the drawing of the field will still be on the paper after removing the magnet. • It is difficult to draw individual field line separately in iron-filing method even if the filings are sprinkled very thinly and evenly.	1A 1	

Solution	Marks	Remarks
8. (a) (i) 	1A	
	1	
(ii) Brightness increases.	1A	
	1	
(b) (i) Resistance $= \frac{V}{I} = \frac{20}{0.5}$	1M	
$= 40\ \Omega$	1A	
	2	
(ii) As the applied voltage V increases, current I / electrical power increases	1A	
and this raises the filament's temperature,	1A	
thus the resistance R of the filament / bulb increases.		
Or the electrons collide with the increasingly vibrating atoms / lattice ions (of the filament) which impede their flow, i.e. R increases.	1A	
	2	
(c) (i) 	1M	Correct straight line intersects the curve at (8, 0.3)
Current = 0.3 A (at V = 8 V)	1A	
	2	
(ii) Power consumed $= IV$		
$= (0.3)(8)$	1M	e.c.f. from (c)(i)
$= 2.4$ W	1A	
	2	

Solution	Marks	Remarks
9. (a) Induced current is anticlockwise (i.e. in the direction $ZYXW$) 	1A	
	1	
(b) Current $I = \frac{\varepsilon}{R} = \frac{Blv}{R}$ [Or $\varepsilon = \frac{N\Delta\Phi}{\Delta t} = \frac{B\Delta A}{\Delta t} = Blv = IR$]		
$0.01 = \frac{0.03(0.10)v}{4 \times 0.15}$	1M	
$v = 2.0\ \text{m s}^{-1}$	1A	
Or Power input $P = Fv = I^2R$ $(IlB)v = I^2R$ $Blv = IR$		
$(0.03)(0.10)\ v = (0.01)(4 \times 0.15)$	1M	
$v = 2.0\ \text{m s}^{-1}$	1A	
	2	
(c) (i) $V_{YZ} = I\,(R_{ZW} + R_{WX} + R_{XY})$	1M	
$= 0.01(0.15 + 0.15 + 0.15)$		
$= 0.0045$ V (= 4.5 mV)	1A	
Or $V_{YZ} = \varepsilon - IR_{YZ}$	1M	
$= Blv - IR_{YZ}$ $= 0.03(0.10)(2.0) - 0.01(0.15)$		
$= 0.0045$ V	1A	
	2	
(ii) As there is voltage drop (IR_{YZ}) within / across YZ, V_{YZ} is less than the induced e.m.f. across YZ ($\varepsilon = Blv$)	1A	Note: $\varepsilon - IR_{YZ} = V_{YZ}$ $\varepsilon = 0.006$ V
	1	
10. (a) Decrease in mass in the reaction (for two ${}^2_1$H)		
$\Delta m = (2 \times 2.014102) - (3.016029 + 1.008665)$	1M	
$= 4.028204 - 4.024694 = 0.003510$ u		
Maximum energy released by 1 mole of hydrogen nuclides		
$= \left(\frac{6.02 \times 10^{23}}{6420 \times 2}\right) \times (0.003510 \times 931\ \text{MeV})$	1M	
$= 1.532104 \times 10^{20}$ (MeV) $\approx 1.53 \times 10^{20}$ (MeV)	1A	
	3	
(b) ${}^2_1\text{H} + {}^2_1\text{H} \rightarrow \underline{{}^3_1\text{H} + {}^1_1\text{H}}$ (or $\underline{{}^1_1\text{p}}$)	1A	
	1	
(c) Any TWO: - Unlike fission, the fuel (hydrogen) for fusion is abundant and widely available. - Unlike fission, the products of fusion reactions are not radioactive. - Much larger amount of energy is produced by fusion (for equal mass of fuel).	2A	
	2	

Paper 2

Section A : Astronomy and Space Science

1. B (64%)	2. A (39%)	3. C (23%)	4. D (56%)
5. A (55%)	6. C (37%)	7. C (42%)	8. B (46%)

Solution	Marks	Remarks
1. (a) Gravitational acceleration on a celestial body's surface is given by		
$g = \frac{GM}{R^2}$ (as $F = \frac{GMm}{R^2} = mg$)	1M	
$\therefore \frac{g_M}{g_E} = \left(\frac{M_{Moon}}{M_{Earth}}\right)\left(\frac{R_{Earth}}{R_{Moon}}\right)^2$		
$= (0.0123)(\frac{1}{0.273})^2 = 0.165036 \approx 0.165$ (3 sig. fig.)	1A	Accept 0.164 ~ 0.166
	2	
(b) (i) Let r be the distance of N from the Earth's centre,		
$\frac{GM_{Earth}m}{r^2} = \frac{GM_{Moon}m}{(D-r)^2}$ or $\frac{GM_{Earth}}{r^2} = \frac{GM_{Moon}}{(D-r)^2}$	1M	
$\frac{D-r}{r} = \sqrt{\frac{M_{Moon}}{M_{Earth}}} = \sqrt{0.0123}$		
$r = \frac{1}{1+\sqrt{0.0123}}D = 0.900167\,D \approx 0.90\,D$	1A	Accept 0.89 D ~ 0.91 D
	2	
(ii) The required kinetic energy = increase in gravitational potential energy	1M	
$\frac{1}{2}mv^2 = m(6.12 \times 10^7)$		
$v = 11063.453$ m s^{-1} ≈ 11.1 km s^{-1}	1A	Accept 11.0 km s^{-1} ~ 11.2 km s^{-1}
	2	
(c) (i) redshift	1A	
	1	
(ii) $v = f\lambda$		
$3 \times 10^8 = 20 \times 10^6 \lambda_c$		
$\lambda_c = 15$ m	1M/1A	
radio waves / short waves	1A	
	2	
(iii) Period: I	1A	
	1	

Section B : Atomic World

1. A (26%)	2. D (40%)	3. C (45%)	4. A (33%)
5. B (53%)	6. D (46%)	7. C (49%)	8. B (18%)

Solution	Marks	Remarks
2. (a) (i) As wavelength / frequency / energy of photon remains unchanged, the same maximum kinetic energy KE_{max} for the electrons emitted.	1A	
The range does not depend on the intensity of incident light, i.e. remains unchanged.	1A	
	2	
(ii) Assuming all incident photons cause emission of electrons, maximum no. of electrons emitted in 1 second		
$= \frac{(0.050)(1.00\times10^{-4})}{4.97\times10^{-19}} = 1.00603622 \times 10^{13}$	1M	
$\approx 1.01 \times 10^{13}$	1A	Accept 1.00×10^{13} ~ 1.01×10^{13}
	2	
(b) $KE_{max} = eV_s$ (or q_eV_s)		
$1.9 \times 10^{-19} = eV_s$	1M	
$V_s = \frac{1.9\times10^{-19}}{1.60\times10^{-19}}$		
$= 1.1875$ V ≈ 1.19 V	1A	
	2	
(c) Threshold wavelength $\lambda_0 = 6.6 \times 10^{-7}$ m (from graph)	1M	
Work function $= \frac{hc}{\lambda_0} = \frac{(6.63\times10^{-34})(3.00\times10^8)}{6.6\times10^{-7}}$	1M	
$= 3.0136 \times 10^{-19}$ J		
$= \frac{3.0136\times10^{-19}}{1.60\times10^{-19}} = 1.88$ (eV)	1A	Accept 1.87 (eV) ~ 1.93 (eV)
<u>Or</u> Work function $= \frac{hc}{\lambda} - KE_{max}$	1M	
$= \frac{(6.63\times10^{-34})(3.00\times10^8)}{4\times10^{-7}} - 1.9 \times 10^{-19}$	1M	
$= 1.92$ (eV)	1A	
	3	
(d) decrease	1A	
	1	

Section C : Energy and Use of Energy

1. A (74%)	2. A (26%)	3. D (57%)	4. C (46%)
5. C (29%)	6. D (42%)	7. B (74%)	8. D (82%)

Solution	Marks	Remarks
3. (a) (i) Output power = 38 × 10 = 380 W Input power = 1000 × 1.934 = 1934 W Efficiency = $\frac{380}{1934}$ × 100% = 19.648397% ≈ 19.6 %	1M/1A 1A 2	 Accept 19.5 % ~ 20 %
(ii) No. of panels for producing 10 kW = $\frac{10000}{380}$ = 26.315789 ≈ 26 26 panels can be installed, i.e. minimum area = 26 ×1.934 m² = 50.284 m² ≈ 50.3 m²	 1M/1A 1A 2	e.c.f. from (a)(i) Accept 50.2 m² ~ 50.3 m²
(b) (i) It converts direct current (DC) to alternating current (AC).	1A 1	
(ii) 10 kW × 4.5 h × 365 = 16425 (kW h)	1A 1	Accept 16200 (kW h) ~ 16500 (kW h)
(iii) The solar panel is not always facing the sun. Or The sunlight may be blocked by nearby objects. Or The efficiency of the inverter is not 100%.	1A 1A 1A 1	
(iv) 200000 + 5000 × t = 5 × 10000 × t t = 4.44 (years)	1M 1A 2	 Accept 4.4 (years) ~ 4.5 (years)
(c) Solar panels / cells are silent during operation Or lower maintenance cost / installation cost Or comparatively safer as solar panels do not have movable parts	1A 1A 1A 1	

Section D : Medical Physics

1. C (54%)	2. D (71%)	3. B (41%)	4. B (56%)
5. A (55%)	6. A (56%)	7. C (58%)	8. D (46%)

Solution	Marks	Remarks
4. (a) (i) acoustic impedance = density × speed = 1040 × 1630 = 1.6952 × 10⁶ kg m⁻² s⁻¹ ≈ 1.70 × 10⁶ kg m⁻² s⁻¹ (Rayl)	 1A 1	
(ii) $\frac{\sin\theta_{air}}{\sin\theta_{skin}} = \frac{\text{speed of sound in air}}{\text{speed of sound in skin}} = \frac{340}{1520}$ $\sin\theta_{skin} = \frac{1520}{340} \times \sin 5° = 0.39$ $\Rightarrow \theta_{skin} = 22.93° \approx 22.9°$	1M 1A 2	
(iii) Refraction distortions occur when the ultrasound beam is bent from its original direction as it passes through a boundary between tissues having different sound speeds. (One would assume that the beam goes straight in ultrasound scans and does not know that the sound path has been altered due to refraction.) It results in improper positioning and/or brightness of echoes displayed in ultrasound images.	1A 1A 2	
(b) (i) Radionuclide image (bone scan) – radioactive γ source (radio-pharmaceutical) is injected to the body and carried to target organs. Different concentration of γ source in the body gives different brightness in image. Chest X-rays – X-rays are produced by an X-ray tube. When X-rays pass through the body from outside, they are absorbed by different tissues. The different attenuation of X-rays gives different brightness in image.	1A 1A 1A 3	
(ii) (Explain in terms of selective uptake of radionuclide and functional information of the organ.) Radio-pharmaceutical targets the bone / organ due to selective uptake as (bone) hot spots. Hence bone scan / RNI detects function (or physiology) due to the metabolic uptake of the radio-pharmaceutical rather than anatomy as do X-rays. It helps to locate where the cancer has been spread.	 1A 1A 2	

Candidates' Performance

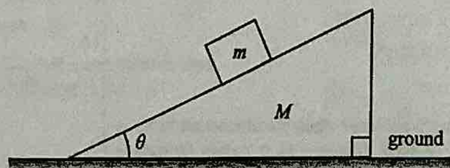
Paper 1

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.

6.

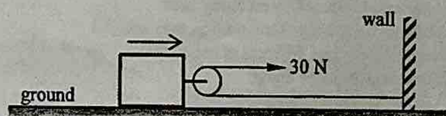


A block of mass m is placed on a wedge of mass M as shown. The system remains at rest. What is the normal force exerted on the wedge by the ground ?

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

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

10.

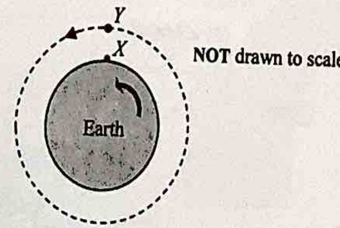


On a horizontal ground there is a block attached with a smooth light pulley as shown. A light and inextensible horizontal string, with one end fixed to a wall, passes the pulley. A man exerts a horizontal force of 30 N at the other end of the string and pulls a distance of 4 m. Find the work done by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

A.	20 J	(5%)
B.	80 J	(56%)
C.	100 J	(7%)
*D.	120 J	(32%)

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

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



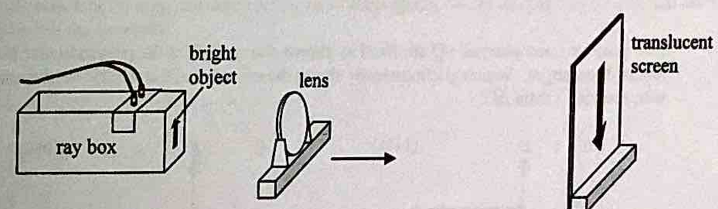
Which descriptions about the motion of X and Y are correct ?

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

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

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

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



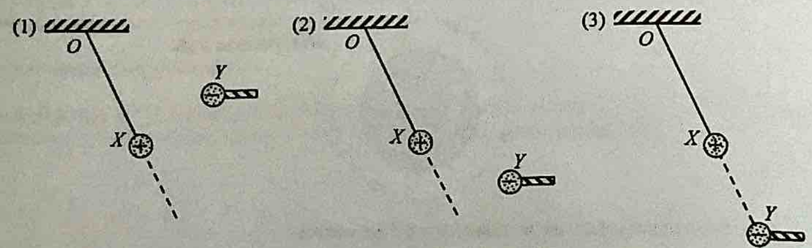
The first sharp image formed is inverted as shown and its length is 9 cm. When the lens is moved further towards the screen, a second sharp image of length 1 cm is observed. Which of the following statements is/are correct ?

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

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

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

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

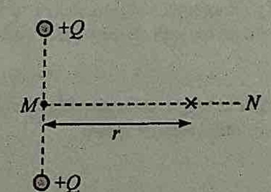


In which situation(s) could X be kept at rest as shown ?

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

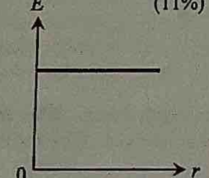
Less than one quarter of the candidates answered this item correctly suggesting that most of them did not fully understand the conditions for coplanar forces to achieve equilibrium.

24.

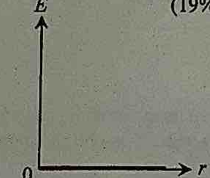


Two positive point charges $+Q$ are fixed as shown above. MN is the perpendicular bisector of the line joining the charges. Which graph correctly shows the variation of the electric field strength E on line MN with distance r from M ?

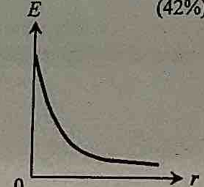
A. (11%)



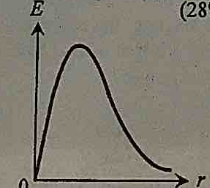
B. (19%)



C. (42%)

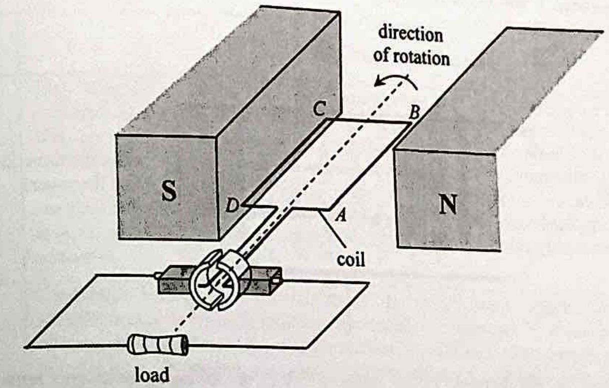


*D. (28%)



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

28.



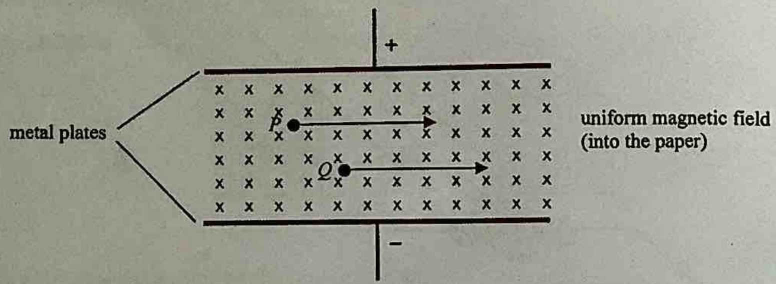
The figure shows the structure of a simple generator. Which of the following statements is/are correct ?

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

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

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

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



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

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

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

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

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

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

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

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

Section B (conventional questions)

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

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

Paper 2

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

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