2014 HKDSE Physics & Combined Science (Physics)

Report on Assessment

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Overview

Paper	Physics	CS(Phy)
1A (MC)	Mean: 18 out of 33 (i.e.55%) (2013: 19 out of 36)	Mean: 9 out of 22 (i.e.42%) (2013: 9 out of 24)
1B	~>50% (2013: ~>45%)	~>40% (2013: ~<40%)
2	~>50% (2013: ~<50%)	N.A.
SBA	~>70% (~2013)	~<70% (~2013)
Candidature	ALL: 14 230 SCH: 12 867	ALL: 1 929 SCH: 1 789

2

Marking & Grading

On-Screen Marking (OSM) panels	
Physics	**CS(Phy)**
1B-1: Q.1, 3, 4 1B-2: Q.5, 6, 8, 9	1B-1: Q.1, 2, 3 1B-2: Q.4, 5, 6, 7
1B-3: Q.2, 7, 10	---
2A: Astronomy (21%) 2B: Atomic World (68%) 2C: Energy (85%) 2D: Medical Physics (26%)	---

SBA marks stat. moderated with both Mean and SD adjusted (outlining cases reviewed by Supervisors)

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Marking & Grading

- The same Expert Panel (Chief Examiners, 5 persons) determine level boundaries/cut scores based on **Level descriptors / Group Ability Indicator (GAI) / Viewing student samples**.
- CS(Phy) graded by **Common items / Viewing student samples.**
- Endorsement by Senior Management/Exam Board

Note: GAI is calculated from Physics candidates' actual awards obtained in 4 core subjects CEML.

4

Results

Physics

Cut score difference = 47 marks

Level	5**	5+	4+	3+	2+	1+
Percentage	2.7%	27.2%	50.5%	74.2%	90.5%	98.1%
No. of MC	29	23	18	14/13	10	7

CS(Phy)

Cut score difference = 43 marks

Level	5**	5+	4+	3+	2+	1+
Percentage	1.1%	10.8%	24.4%	48.7%	72.9%	92.5%
No. of MC	17	14	12	10/9	7	5

5

Paper 1A

Physics (33 MC)

>70%	50%-70%	<50%
8	14	11

Easy ⟷ Difficult

CS (Phy) (22 MC)

>70%	50%-70%	<50%
4	4	14

Easy ⟷ Difficult

6

PHYSICS MC

Topic (No. of Qu.)	Average % correct	No. of Qu. < 50% correct
Heat & Gases (2)	69%	0
Force & Motion (10)	54%	4
Wave Motion (7)	68%	1
Electricity & Magnetism (11)	46%	6
Radioactivity (3)	57%	0

7

CS(PHY) MC

Topic (No. of Qu.)	Average % correct	No. of Qu. < 50% correct
Heat & Gases (2)	49%	1
Force & Motion (8)	40%	6
Wave Motion (7)	54%	2
Electricity & Magnetism (5)	26%	5

8

6. Two small identical blocks slide down from rest on smooth incline planes from the same height H as shown in Figure (1) and Figure (2) below. Their respective speeds at the bottom of the incline planes are denoted by v_1 and v_2 and the respective times taken to reach the bottom are t_1 and t_2. Which of the following is correct? Neglect air resistance.

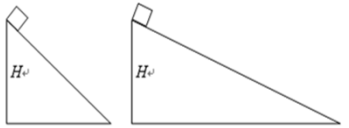
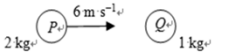


Figure (1) Figure (2)

		PHY	CS(PHY)
A.	$v_1 > v_2$ and $t_1 = t_2$	(12%)	(15%)
B.	$v_1 > v_2$ and $t_1 < t_2$	(33%)	(50%)
C.	$v_1 = v_2$ and $t_1 = t_2$	(10%)	(10%)
* D.	$v_1 = v_2$ and $t_1 < t_2$	(45%)	(25%)

9

7.



A sphere P of mass 2 kg makes a head-on collision with another sphere Q of mass 1 kg which is initially at rest. The speed of P just before collision is 6 m s^{-1}. If the two spheres move in the same direction after collision, which of the following could be the speed(s) of Q just after collision?

(1) 2 m s^{-1}
(2) 4 m s^{-1}
(3) 6 m s^{-1}

		PHY	CS(PHY)
A.	(1) only	(6%)	(10%)
B.	(1) and (2) only	(36%)	(41%)
* C.	(2) and (3) only	(26%)	(25%)
D.	(1), (2) and (3)	(32%)	(24%)

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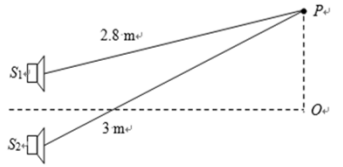
11. An astronaut inside a spacecraft moving in a circular orbit around the Earth is apparently weightless because

A.	the astronaut is too far from the Earth to feel the Earth's gravitational force.		(25%)
* B.	the astronaut and the spacecraft are both moving with the same acceleration towards the Earth.		(29%)
C.	the Earth's gravitational force on the astronaut is balanced by the reaction force of the spacecraft's floor.		(9%)
D.	the Earth's gravitational force on the astronaut is balanced by the centripetal force.		(37%)

11

18.

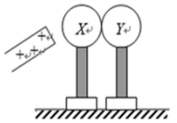


S_1 and S_2 are two loudspeakers connected to a signal generator but the sound waves produced by them are in anti-phase. Point O is equidistant from the loudspeakers while point P is at the distances shown in the figure from the loudspeakers. What type of interference occurs at O and P if the wavelength of the sound waves is 10 cm?

	O	P	PHY	CS(PHY)
A.	destructive	constructive	(14%)	(21%)
B.	constructive	constructive	(31%)	(29%)
* C.	destructive	destructive	(41%)	(26%)
D.	constructive	destructive	(14%)	(24%)

12

20.

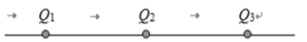


Two insulated uncharged metal spheres X and Y are placed in contact. A positively-charged rod is brought near X as shown. X is then touched by a finger momentarily and the two spheres are then separated by removing Y. The charged rod is removed afterwards. Which of the following describes the charges on X and Y?

	sphere X	sphere Y	PHY	CS(PHY)
A.	uncharged	uncharged	(12%)	(18%)
B.	uncharged	positive	(29%)	(33%)
* C.	negative	uncharged	(44%)	(34%)
D.	negative	negative	(15%)	(15%)

13

21.

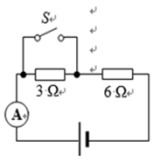


Three point charges Q_1, Q_2 and Q_3 are fixed on a straight line with Q_2 at the mid-point of Q_1 and Q_3. The resultant electrostatic force on each charge is zero. Which of the following can be the sign and magnitude (in the same arbitrary units) of Q_1, Q_2 and Q_3?

	Q_1	Q_2	Q_3	PHY	CS(PHY)
A.	+2	+1	+2	(11%)	(19%)
B.	+2	−1	+2	(28%)	(32%)
C.	−4	+1	+4	(18%)	(28%)
* D.	−4	+1	−4	(43%)	(21%)

14

24.



In the above circuit, the cell has constant e.m.f. and a fixed internal resistance. When S is closed, the ammeter reads 3.0 A. When S is open, which of the following is a possible reading of the ammeter?

A.	1.6 A		(9%)
B.	2.0 A		(63%)
* C.	2.4 A		(20%)
D.	3.2 A		(8%)

15

27.

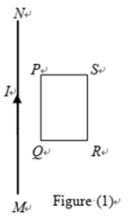


Figure (1)

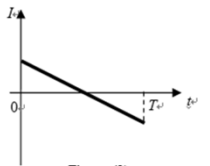


Figure (2)

A long straight current-carrying wire MN and a rectangular coil $PQRS$ are fixed in the same plane as shown in Figure (1). The current I is taken as positive when it flows from M to N and it varies with time t as shown in Figure (2). The direction of the induced current in the coil during the time interval $0 - T$ is

		PHY	CS(PHY)
A.	first anti-clockwise and then clockwise.	(34%)	(31%)
B.	first clockwise and then anti-clockwise.	(29%)	(38%)
C.	anti-clockwise throughout.	(15%)	(18%)
* D.	clockwise throughout.	(22%)	(13%)

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Observations

- Most candidates were competent in handling calculations ***except*** proportional relations & percentage errors.
- Quite weak or careless in handling units/converting units or scientific notations.
- Not familiar with subtle precautions / procedures of some experiments.
- Weaker candidates (Level 1 & 2) tend to give up answering essay questions or descriptive parts. They also performed poorly in Paper 2.

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Points to note

- As in previous years, ~70% of Paper 1 (Physics) with questions from core part.
- Accept answers using
  $g = 9.81$ or $10\ m\ s^{-2}$.
- Method marks 'M' awarded to correct formula / substitution
- In general, numerical ans. with 3 sig. fig. Answer marks 'A' awarded to correct numerical answer in correct unit within tolerance range.

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Points to note

- Equating Electives (Total = 80 each) using Paper 1

  Before equating: Mean 36 to 39 / SD 16 to 20
  After equating: Mean 39 to 44 / SD 16 to 18

  2A Astronomy: ↑↑
  2B Atomic World: ↑↑
  2C Energy: ↑
  2D Medical Physics: unchanged

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Points to note

- From 2014 Exam onwards:
  PHY no. of MC = 33
  CS(PHY) no. of MC = 22
- Student samples of performance (Levels 1 to 5) available in October (HKEAA website).
- SBA Conference on 15 Nov 2014
- SBA Online Submission in Jan/Feb 2015
- All SBA tasks adopt 0 – 20 mark range.

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2014 DSE PHYSICS/ COMBINED SCIENCE(PHYSICS)

IB-2

Y S HO

W I TANG

QUESTION 5(a)

- MARKING SCHEME

$n = \frac{\sin i}{\sin r}$ [1M]

$= \frac{\sin 60°}{\sin 36°}$

$= 1.47$ [1A]

- SAMPLE

$n_1 \sin\theta_1 = n_2 \sin\theta_2$ √

$1 \sin 60° = n_2 \sin 36$

$n_2 = 1.47$ √

$\frac{\sin 30°}{\sin 54°}$ ×

$= 0.618$ ×

折射率 $= \frac{\sin 60°}{\sin 30°}$ ×

$= 1.73$ ×

- COMMENTS

Well answered.

Some candidates mistook 30° and 54° as the angles of incidence and refraction respectively.

QUESTION 5(b)

- MARKING SCHEME

$\sin c = \frac{1}{n} = \frac{1}{1.473}$ [1M]

$c = 42.7° < 54°$ [1M]

(1M for comparing incidence angle with c)

- SAMPLE

It is because the refractive index of glass is higher than the air. Therefore it occured.

0 mark

∴ 光射於入角大於區點黑角 √

∴ 光射在Q点上发生全内反射 √

1 mark only

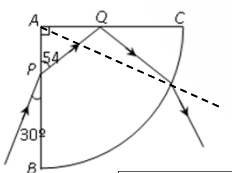
- COMMENTS

Quite a number of candidates did not explicitly calculate the critical angle for comparison in (b).

Some even wrongly thought that the angle of incidence was 60°.

QUESTION 5(c)

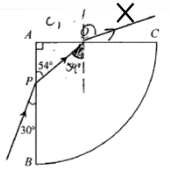
- MARKING SCHEME



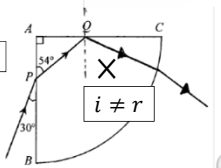
$i = r$ [1A]

Emergent ray away from normal [1A]

- SAMPLE



Deduct 1 mark for wrong arrow.



- COMMENTS

Some candidates were not aware that the angle of incidence should be equal to the angle of reflection at Q.

Weaker candidates failed to draw the correct emergent ray.

QUESTION 5(d)

- MARKING SCHEME

A spectrum is seen. [1A]

- SAMPLE

The white light is diffracted to different colours.

the dispersion of color of light √

Different colour of light can be observed. √

- COMMENTS

Some candidates confused ***refraction*** and ***diffraction***, ***visible light spectrum*** and ***line spectrum***, etc.

QUESTION 6(a)

- MARKING SCHEME

Convex/converging lens [1A]

(correct spelling)

Refracted ray of *A* after passing through *L* bends towards the principal axis. [1A]

- SAMPLE

Convex lens √ Since A an B focuscus behind the lenses and form real √ image.

凸透镜√ 因为它 [illegible] 折射偏近法线 ×

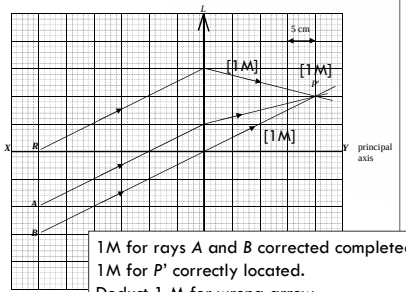
- COMMENTS

A few candidates had wrong spelling in 'convex lens'.

Some candidates misused the term 'normal' instead of 'principal axis'.

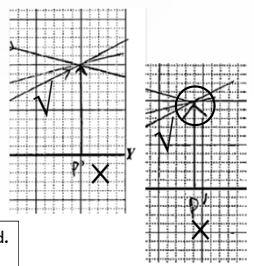
QUESTION 6(b)(i)

- MARKING SCHEME



1M for rays *A* and *B* corrected completed.
1M for *P'* correctly located.
Deduct 1 M for wrong arrow.

- SAMPLE



- COMMENTS

Many candidates overlooked the fact that the parallel rays all came from a point and wrongly drew and labelled an arrow sign as the image.

QUESTION 6(b)(ii)

- MARKING SCHEME

$f = 20$ cm [1A]

(Accept 19 – 21 cm)

- SAMPLE

Focal length = 22cm ×.

焦距 = [illegible] 10cm. ×

焦距 = 7.5cm ×.

- COMMENTS

A few candidates misread the focal length as 10 cm from the ray diagram.

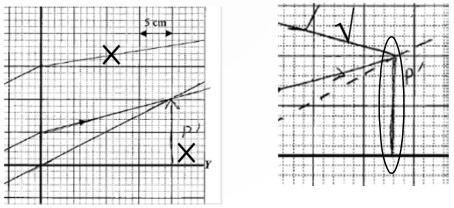
QUESTION 6(c)

- MARKING SCHEME

Ray *R* correctly completed [1M]

(Towards the intersection of the refracted rays of *A* and *B*)

- SAMPLE



- COMMENTS

Only the more able ones knew that the light rays coming from the same point should intersect at the corresponding position of the image after passing through the lens.

QUESTION 6(d)

- MARKING SCHEME

Use a screen to capture a sharp image of a distant object. [1A]

The distance between the screen and the lens is *f*. [1A]

- SAMPLE

Put a light source 40 cm away from the lens. Use a translucent screen to find the image distance until a sharp image is observed. The focal length can be determined by using the lens formula: $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ X

- COMMENTS

Some candidates did not follow the requirement stated in (d) and employed an experimental method using a ray box, instead of a distant object, to determine the focal length *f* according to the lens formula $1/f = 1/u + 1/v$.

Move the position of lens L until there is no image formed X It shows that the image is infinite for and the distance between the object and the lens are the focal lengths.

QUESTION 8(a)

- MARKING SCHEME

$$P = \frac{V^2}{R}$$

$$500 = \frac{220^2}{R}$$

$R = 96.8\,\Omega$ [1A]

- SAMPLE

$R = \frac{500}{220}$

$R = 2.27\,\Omega$ X

Apply $P = VI$, $V = IR$

$P = \frac{V^2}{R}$

$500 = \frac{200^2}{R}$

$R = 80\,\Omega$ X

- COMMENTS

Well answered

QUESTION 8(b)

- MARKING SCHEME

$$Total\ power = \frac{V^2}{2R}$$ [1M]

$$= \frac{220^2}{2 \times 96.8}$$

$= 250$ W [1A]

- SAMPLE

$I = \frac{220}{96.8\Omega} = 1.14\,A$ √

$P = 1.14^2 (96.8 \times 2)$ √

$= 250$ W √

$R = 96.8 + 96.8 + \left(\frac{96.8}{2}\right)$ X

$= 242\,\Omega$

$P = \frac{220^2}{242}$

$= 200$ W X

- COMMENTS

Some weaker candidates failed to identify the resistance network involved in mode X.

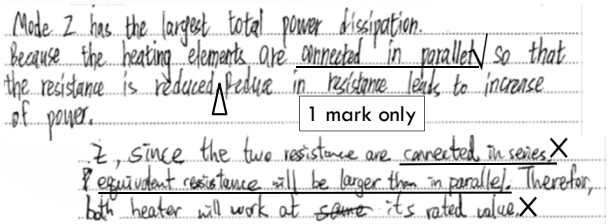
QUESTION 8(c)

- MARKING SCHEME

In mode Z, the equivalent resistance is the least as they are connected in parallel, [1A]

Hence, under the same voltage, the total power is the largest since $P = \frac{V^2}{R}$ [1A]

- SAMPLE



1 mark only

- COMMENTS

Many candidates were able to identify *overall resistance least* for parallel connections but did not state that the power dissipation is inversely proportional to the resistance under the same voltage.

QUESTION 8(d)(i)

- MARKING SCHEME

For mode Z,

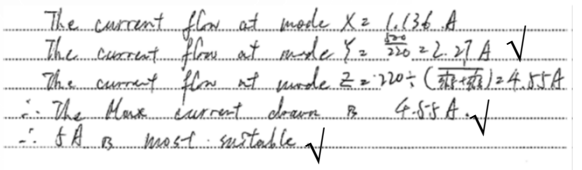
$$total\ power = 2 \times 500 = 1000\ \text{W}$$

$$I_z = \frac{P}{V} = \frac{1000}{220} = 4.55\ \text{A}$$ [1M + 1M]

Most suitable value of fuse = 5 A [1A]

1M for finding either total current
1M for finding current for mode Z

- SAMPLE



- COMMENTS

Quite a number of candidates failed to identify the mode that corresponds to the largest operating current.

QUESTION 8(d)(ii)

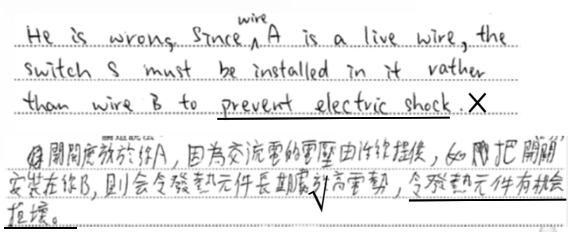
- MARKING SCHEME

Although the heater still works in either connection, it is dangerous for switch S to be fitted in wire B(neutral) [1A]

as the heater would still be live even when the switch was turned off. [1A]

Corr. conclusion w/corr. explanation

- SAMPLE



- COMMENTS

Most candidates knew that the switch S should be installed in the live wire, however, not many were able to point out the hazards of not doing so.

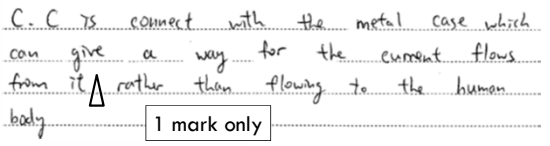
QUESTION 8(d)(iii)

- MARKING SCHEME

Wire C [1A]

Current would be conducted from the case through this wire to the earth. [1A]

- SAMPLE



1 mark only

- COMMENTS

Well answered.

QUESTION 9(a)

- MARKING SCHEME

Correct connections shown [1A]

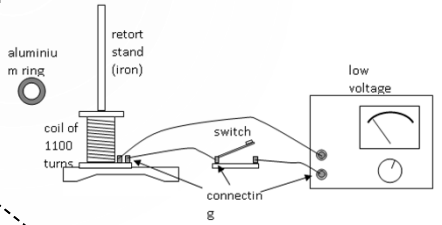
Put the aluminium ring on the top of the coil through the rod of the retort stand. [1A]

When closing the switch, the ring would shoot up the rod once, [1A]

as the aluminium ring experiences a changing magnetic field [1A]

According to Lenz's law, eddy currents flow in the ring to oppose the change. [1A]

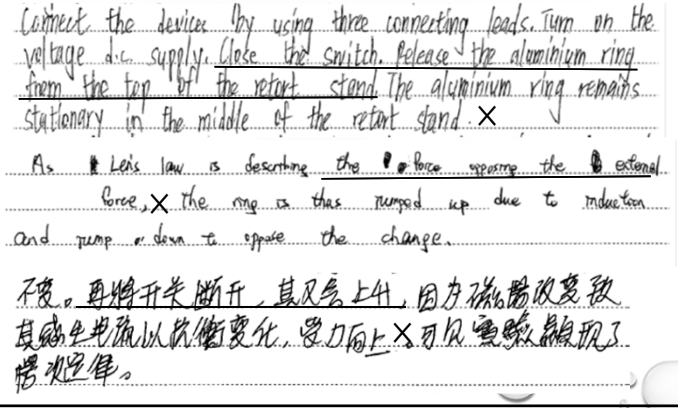
When the current and thus the resulting magnetic field are constant, the ring would fall back to the coil as eddy currents no longer flow. [1A]



For closing the switch before placing the ring, candidates could not get these 2A

QUESTION 9(a)

- SAMPLE



QUESTION 9(a)

- COMMENTS

Many candidates omitted that the ring would fall back to the coil when the current becomes constant.

Some candidates did not understand Lenz's law and were not able to express their answer clearly.

Some even confused the apparatus with the Lenz's law apparatus – a small magnet falling through a metal tube.

QUESTION 9(b)(i)

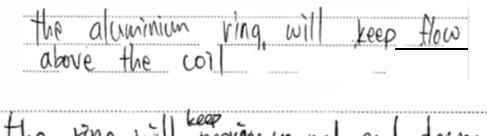
- MARKING SCHEME

The aluminium ring would float in the air. [1A]

- COMMENTS

Quite a number of candidates confused the words '*flow*' and '*float*'.

- SAMPLE



QUESTION 9(b)(ii)

- MARKING SCHEME

The aluminium ring with a slit would remain stationary. [1A]

- COMMENTS

A few candidates failed to give precise answers and stated *no change* or *no observation* etc

- SAMPLE

No observation ✗

the ring will drop to the coil.

2014 DSE PHYSICS/ COMBINED SCIENCE (PHYSICS)

Mr. Y.H. Mui

Mr. W.C. Ng

QUESTION 2

Marking Scheme	Performance/Common Errors
(a)(i) $P_1V_1 = P_0V_0$ (156 kPa)(6000 cm^3) = (100 kPa)V_0 [1M] V_0 = 9360 cm^3 [1A] ∴ volume of air = V_0 – volume of the basketball = 9360 cm^3 – 6000 cm^3 = 3360 cm^3 [1M]	- Did not understand the relationship between pressure and volume in the context of pumping a ball. $\frac{p_1}{n_1} = \frac{p_2}{n_2}$ ✘ $\frac{100}{6000} = \frac{156}{n_2}$ $n_2 - 6000 = 3360 cm^3$

QUESTION 2

Marking Scheme	Performance/Common Errors
(a)(ii) Number of strokes required = 3360 cm^3 ÷ 120 cm^3 = 28 [1A]	
(b) As the volume and the temperature (∝ kinetic energy of the air molecules) remains unchanged, [1A] the increase in pressure is due to the increase of number of air molecules hitting the wall of the container per unit time. [1A]	- Few candidates were able to state that both temperature and volume were constant.

QUESTION 2 (SAMPLE 1)

(a) (i) Show that 3360 cm^3 of air, originally at atmospheric pressure, is required to be pumped into the basketball until its pressure is suitable for an official match. Assume that the volume of the basketball remains unchanged at 6000 cm^3. (3 marks)

$pV = nRT$?

$\frac{100 \times 1000}{156 \times 1000} = \frac{6000}{6000 + x}$

$x = 3360\ cm^3$ ✓

0M

1M

1A

QUESTION 2 (SAMPLE 2)

(a) (i) 證明需把 3360 cm^3 原本處於大氣壓強的空氣壓注入籃球，方能使其壓強適用於正式比賽。設籃球的體積 6000 cm^3 保持不變。 (3 分)

∵ $PV = nRT$ ∴ $P \propto \frac{1}{V}$

若使籃球適用于正式比賽

需要 $\frac{V_2}{V_1} = \frac{P_2}{P_1}$ ✗

即 $\frac{V_2}{V_1} = \frac{3360+6000}{6000} = 1.56$

$\frac{P_2}{P_1} = \frac{156}{100} = 1.56$ **0M**

∴ 打氣后 $\frac{V_2}{V_1} = \frac{P_2}{P_1}$ **0M**

即 只压可达到 156 kPa **0A**

QUESTION 2 (SAMPLE 3)

(b) Use kinetic theory of an ideal gas to explain the increase of pressure inside the basketball when air is pumped into it. (2 marks)

When air is pumped, since the volume is fix, the air molecules ✓ has more collisions in a fix container. With them, temperture increase ✗ and pressure increase.

0A

1A

QUESTION 7

Marking Scheme	Performance/Common Errors
(a)(i) $\tan\theta = 0.38$ $\theta = 20.8°$ [1A]	- Accept "$\tan\theta = 0.38$" as answer. - Well answered
(ii) $d\sin\theta = n\lambda$ As $d = \frac{1}{300}\times10^{-3}$ [1M] $(\frac{1}{300}\times10^{9})\times\sin 20.8° = 2\lambda$ [1M] $\lambda = 5.92\times10^{-7} m$ [1A]	- 1M for sub. d - 1M for sub. θ and correct order

QUESTION 7

Marking Scheme	Performance/Common Errors
(a)(iii) Small percentage error in x / the diffraction angle θ. [1A]	- Poorly answered - Most candidates wrote "small error in x" .
(b) Repeat the procedures with the pin on the left-hand side of the observer. [1A] Take the average value of x obtained from both sides to calculate λ. [1A]	- Most candidates did not understand the experiment. - 1A for locating the central fringe

QUESTION 7 (SAMPLE 1)

*(ii) Hence find the wavelength of the light from the lamp. (3 marks)

300×1

$d\sin\theta = n\lambda$

$(300\times10^{-3})\sin\theta = (2)\lambda$ ✓

$\lambda = 0.05$ cm ✗

✗

0M

1M

0A

QUESTION 7 (SAMPLE 2)

(a) –(iii) Give **ONE** advantage of measuring the position of the second-order image instead of the first-order one. (1 mark)

Since the amount of λ in second-order is larger than that in the first order, it is more easy to measure and the result would be more accurate ✗

0A

QUESTION 7 (SAMPLE 3)

(b) 在這個實驗中，發光狹縫未必完全對準米尺 *A*。試建議一個減低該誤差的方法。 (2 分)

用胶纸固定米尺，让米尺紧靠发光灯并保持垂直. ✗

0A

0A

QUESTION 10

Marking Scheme	**Performance/Common Errors**
(a) Alpha particles emitted can be stopped by the (thin) metallic casing. [1A] OR Shorter range/ Lower penetrating power	- Well answered
(b)(i) $k = \frac{\ell n2}{t_{1/2}} = \frac{\ell n2}{87.74\times3.16\times10^{7}}$ [1M] $= 2.5\times10^{-10}\ s^{-1}$ or $7.9\times10^{-3}\ year^{-1}$ Activity $A = kN$ $= \frac{\ell n2}{87.74\times3.16\times10^{7}}\times3.2\times10^{25}$ [1M] $= 8.000\times10^{15}$ (Bq) [1A]	-Well answered - Accept omitting 3.16×10^{7} s when finding k -1M for sub. k and N into correct equation - Accept 7.99

QUESTION 10

Marking Scheme	Performance/Common Errors
(b)(ii) Power = Energy per decay × Activity = 5.5 MeV × 8.000 × 10^{15} Bq [1M] = 5.5 × 10^{6} × 1.60 × 10^{-19} × 8.000 × 10^{15} = 7040 W or 7.040 (kW) [1A]	- poorly answered - kW can be omitted but not W - accept 7070 W
Power $= \left(\frac{5.5}{931} \times 1.661 \times 10^{-27} \times (3 \times 10^{8})^{2}\right) \times 8.000 \times 10^{15}$ [1M] = 7070 W or 7.070 (kW) [1A]	- some wrongly used the total number of plutonium atoms (3.2 × 10^{25}) in their calculation in stead of the activity (8.000 × 10^{15}) .

QUESTION 10

Marking Scheme	Performance/Common Errors
(b)(iii) Activity ∝ N Power ∝ Activity ∴ Percentage of power left $= \left(\frac{1}{2}\right)^{t/t_{1/2}} \times 100\%$ $= \left(\frac{1}{2}\right)^{36/87.74} \times 100\%$ [1M] = 75.25% ≈ 75% [1A]	- poorly answered - Candidates may calculate the 2 powers and got the correct numerical answer. If they used the power found in (b)(ii) which was incorrect, 1M only

QUESTION 10 (SAMPLE 1)

(a) 鈈-238 源是密封在 RTG 的薄金屬盒內。下面相片顯示一位太空總署的員工正徒手處理 RTG。解釋爲什麼該位員工這樣處理並無不妥。 (1 分)

圖 10.1

因為鈈-238 具放射性，直接接觸皮肤有危害。

0A

QUESTION 10 (SAMPLE 2)

(b) (ii) 當一個鈈-238 原子衰變時會釋出 5.5 MeV 的能量。估算在發射時，放射源所提供的功率，以 kW 爲單位。 (2 分)

$E = mc^2$

$= \frac{5.5}{931 \times 1.661 \times 10^{-27}} \times (3 \times 10^{8})^2$

0M

0A

QUESTION 10 (SAMPLE 3)

*(iii) 「航行者 1 號」在發射 36 年後，於 2013 年 9 月剛離開了太陽系，由此可見「航行者 1 號」的 RTG 仍在運作，估算此時鋦放射源所提供的功率，表達爲在發射時的功率的**百分比**。 (2 分)

$k = \frac{\ln 2}{87.74} = 7.90 \times 10^{-3}\ yr^{-1}$

$A = A_0 e^{-7.90\times(10^{-3})(36)}$ ✓

$\frac{A}{A_0} = 0.752$ **1M**

∴ 百分比 = 75.2% ✓ **1A**

THANK YOU!

PAPER 2

Section A : Astronomy and Space Science

Mr W.K. Lee / Mr N.C. Leung

Q.1 Multiple-choice questions

	A	B	C	D
1.1	24.31	12.45	7.47	**55.08**
1.2	**31.02**	32.09	26.17	9.24
1.3	5.39	17.15	**52.99**	23.87
1.4	**38.81**	28.28	20.87	11.19
1.5	5.93	**58.20**	6.59	28.66
1.6	21.37	10.91	16.90	**50.06**
1.7	50.11	10.34	**30.15**	8.70
1.8	18.83	**36.08**	7.82	36.52

Q.1 Multiple-choice questions

1.2 Given that a typical galaxy in the form of a circular disc is of diameter 10^5 ly and thickness 10^3 ly containing about 10^{11} stars, estimate the average separation between two neighbouring stars within the galaxy assuming that the stars are uniformly distributed.

A. 4.3 ly	**(31.02%)**
B. 6.8 ly	(32.09%)
C. 8.9 ly	(26.17%)
D. 43 ly	(9.24%)

$$a = \sqrt[3]{(\pi d \frac{D}{2}^2)}$$

Q.1 Multiple-choice questions

1.4 The violet line (410 nm) of the hydrogen spectrum from a distant celestial body is blue shifted and its wavelength appears 50 nm shorter when observed. What is the observed wavelength of the red line (656 nm) from the same source ?

A. 576 nm	**(38.81%)**
B. 606 nm	(28.28%)
C. 706 nm	(20.87%)
D. 736 nms	(11.19%)

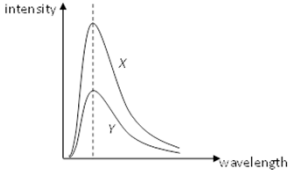
$$\frac{v}{c} = \frac{\Delta\lambda}{\lambda} \Rightarrow \frac{50}{410} = \frac{\Delta\lambda}{656} \Rightarrow \Delta\lambda = 80$$

blue shift $\Rightarrow$ wavelength shorter

$\Rightarrow \lambda = 656 - 80 = 576$ nm

Q.1 Multiple-choice questions

1.7 The diagram shows the spectra of radiation from stars *X* and *Y* with their peaks lying at the same wavelength.



A. Surface temperature of X > Surface temperature of Y (50.11%)

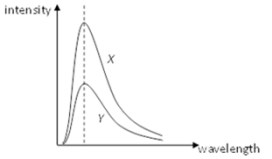
B. Surface temperature of X < Surface temperature of Y (10.34%)

C. Surface temperature of *X* = Surface temperature of *Y* (30.15%)

D. The information is not sufficient to make a comparison of the surface temperature of *X* and *Y*. (8.70%)

Q.1 Multiple-choice questions

1.8 The diagram shows the spectra of radiation from stars *X* and *Y* with their peaks lying at the same wavelength.



A. Star X is smaller than star Y. (18.83%)

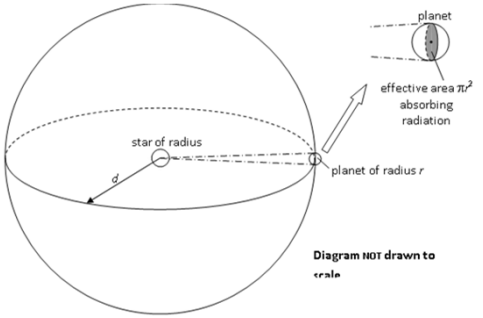
B. Star *X* is bigger than star *Y*. (36.08%)

C. Star *X* and star *Y* are of the same size. (7.82%)

D. The information is not sufficient to make a comparison of the size of stars *X* and *Y*. (36.52%)

Q.1 Structured question

(a) A star of radius *R* and surface temperature T_s (in K) emits radiation in all directions. A planet of radius *r* orbits the star at a distance *d*, which is much larger than both *R* and *r*. Assume that both the star and the planet behave like black bodies.



Q.1 Structured question

Taking the effective area that the planet absorbs radiation emitted from the star as πr^2, show that the power absorbed by the planet is $\pi\sigma(\frac{rR}{d})^2 T_s^4$ where σ is the Stefan constant. Assume that the planet is a perfect absorber of radiation. (2 marks)

(i) Luminosity of the star, $L = 4\pi R^2 \sigma T_s^4$

Power per unit area at distance *d* from the star 1M

$= \frac{L}{4\pi d^2} = \frac{R^2}{d^2}\sigma T_s^4$ Must show the 4π factor in these steps 1M

Power absorbed = $\pi r^2 \times \frac{R^2}{d^2}\sigma T_s^4$

1M for power per m^2 at planet $= \frac{L}{4\pi d^2}$

1M for power = $\pi r^2 \times$ power per m^2

Q.1 Structured question

(ii) If the planet only absorbed energy, its temperature would rise indefinitely. However, this would not happen because the planet also radiates energy as it absorbs energy so that an equilibrium state is maintained. Show that the equilibrium surface temperature of the planet is given by $T_p = \sqrt{\frac{R}{2d}}\,T_s$. (2 marks)

(ii) At equilibrium, power absorbed = power radiated

$$\frac{R^2}{d^2}\pi r^2 \sigma T_s^4 = 4\pi r^2 \sigma T_p^4 \qquad \text{1M}$$

$$\frac{R^2}{d^2} T_s^4 = 4\, T_p^4$$

$$T_p^4 = \frac{R^2}{4d^2} T_s^4 \qquad \text{1M}$$

$$T_p = \sqrt{\frac{R}{2d}}\,T_s$$

1+1

Q.1 (a) Candidates' performance

Fair.

In (a)(i), some candidates confused the effective area πr^2 with the surface area of the sphere $4\pi r^2$. Weaker candidates did not realize that the power per unit area at the planet is given by $\frac{L}{4\pi d^2}$. Some candidates failed to equate the power absorption and power radiation of the planet according to the hint stipulated in (a)(ii).

Q.1 Structured question

b) A planet called Kepler-22b was discovered orbiting a Sun-like star with orbital radius 0.84 AU (1 AU = 1.50×10^{11} m). The star has a radius of 6.82×10^8 m and its surface temperature is 5518 K.

(i) Estimate the equilibrium surface temperature of Kepler-22b using the results of (a). (2 marks)

$$T_p = \sqrt{\frac{R}{2d}}\,T_s$$

$$= \sqrt{\frac{6.82\times10^8}{2\times(0.84\times1.50\times10^{11})}}\,5518 \qquad \text{1M}$$

$$= 287 \text{ K (or 14 °C)} \qquad \text{1A}$$

Q.1 Structured question

(b)(ii) Liquid water is believed to be essential for life to exist on a planet. Based on the information found in (b)(i), explain whether Kepler-22b would be a favourable planet for life to exist or not. (2 marks)

The temperature is between 273 K and 373 K, 1A
(liquid) water is likely to exist on the planet. 1A
Hence the condition is favourable for life to exist.

1A for pointing out 273 K<Tp<373K
Accept "Tp= 287 K / 14 °C > 0°C"
1A for water exists

Correct deduction using (b)(i) ans.;
"error-carried-forward"

Q.1 Structured question

(b)(iii) If Kepler-22b orbits a main sequence class K star instead of a Sun-like star (which is a class G star) with the same orbital radius, would its equilibrium surface temperature increase, decrease or remain unchanged ? State your reason.

Given: the sequence of spectral classes is O B A F G K M.

(2 marks)

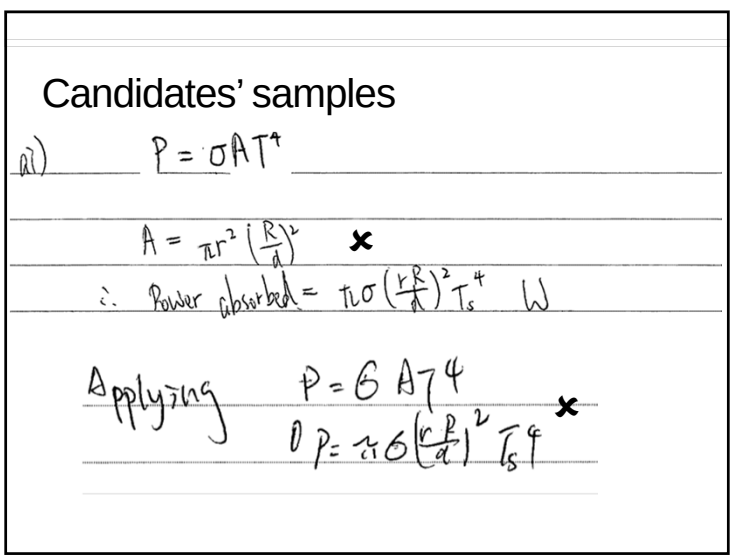
The equilibrium temperature is lower / decreases. 1A

A class K star is a cooler star than a class G star. 1A

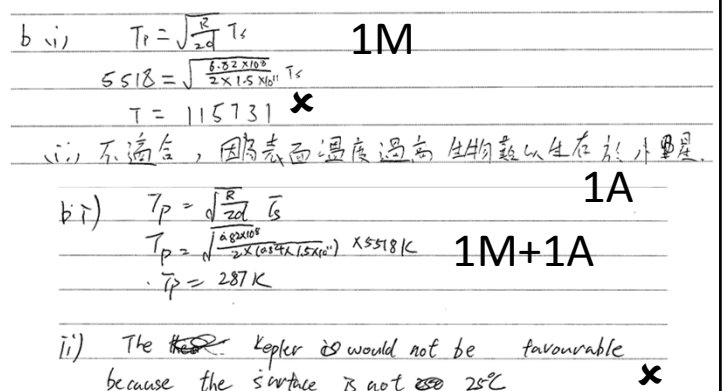
Q.1 (b) Candidates' performance

- Quite a number of the candidates failed to obtain the correct surface temperature in (b)(i),
- however many of them were still able to make a logical deduction in (b)(ii).
- Part (b)(iii) was in general well answered.

Candidates' samples



Candidates' samples



ii) $\left(\frac{T_p}{T_s}\right)^2 = \frac{R}{2d}$ ×

$T_p = \sqrt{\frac{R}{2d}}\, T_s$

bi) $T_p = \sqrt{\frac{R}{2d}}\, T_s$

$= \sqrt{\frac{6.82 \times 10^8}{0.84 \times 1.50 \times 10^{11} \times 2}} \times 5518$

$= 287.1 \text{ K}$ 1M+1A

ii) Yes. It would ~~be~~ be a favourable planet. Its surface temperature is $287.1 - 273 = 14.1\,^\circ\text{C}$, which is between the boiling point and melting point of water. Therefore, water is in liquid state for life to exist. 1A+1A

THANK YOU

Paper 2

Section B : Atomic World

Mr P.C. Ying / Mr M.W. Law

Q.2 Multiple-choice questions

	A	B	C	D
2.1	**71.17**	6.47	7.44	14.83
2.2	12.90	32.82	8.85	**45.29**
2.3	10.33	11.60	**56.98**	20.68
2.4	25.30	14.93	**49.20**	10.37
2.5	23.31	10.53	13.71	**52.23**
2.6	29.55	**46.11**	15.34	8.88
2.7	**42.74**	14.27	19.35	23.57
2.8	16.56	**60.49**	9.01	13.84

Q.2 Multiple-choice questions

2.2 There are dark lines in the spectrum of sunlight. Which of the following statements are correct ?

(1) They are due to the absorption of certain wavelengths of light by the atoms in the Sun's atmosphere.

(2) Light absorbed by the atoms in the Sun's atmosphere is then re-emitted in all directions.

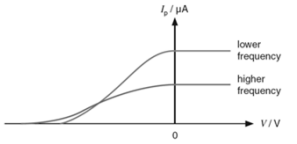
(3) The kinds of atoms present in the Sun's atmosphere can be deduced by the characteristics of the dark lines.

A. (1) and (2) only (12.90%)
B. (1) and (3) only (32.82%)
C. (2) and (3) only (8.85%)
D. (1), (2) and (3) (45.29%)

Q.2 Multiple-choice questions

2.6 A beam of light of frequency f falls on the cathode of a photocell so that photoelectrons are emitted. If the light beam is replaced by another one with the same intensity but having a frequency of $2f$, how would each of the following physical quantities change ? Assume that each incident photon can emit one photoelectron.

V_s : stopping potential
I : magnitude of the saturation photoelectric current



	V_s	I	
A.	increases	increases	(29.55%)
B.	**increases**	**decreases**	**(46.11%)**
C.	remains unchanged	decreases	(15.34%)
D.	decreases	increases	(8.88%)

Q.2 Multiple-choice questions

2.7 The de Broglie wavelength of object *X* is shorter than that of object *Y*. Which of the following deductions must be correct ?

(1) *X* has a higher speed than *Y*.

(2) *X* has a greater momentum than *Y*.

(3) *X* has greater kinetic energy than *Y*.

$$\lambda = \frac{h}{mv}$$

A.	**(2) only**	**(42.74%)**
B.	(1) and (2) only	(14.27%)
C.	(2) and (3) only	(19.35%)
D.	(1), (2) and (3)	(23.57%)

Q.2 Structured question

(a) In a Transmission Electron Microscope (TEM), electrons emitted from the cathode pass through the specimen and the four functional parts listed below before forming an image on a screen.

Functional parts: (1) objective magnetic lens
(2) projection magnetic lens
(3) condensing magnetic lens
(4) anode

Referring to the following block diagram of a TEM, match the functional parts represented by *A*, *B*, *C* and *D* in the diagram. (2 marks)

Cathode	A	B	Specimen	C	D	Screen

Q.2 Structured question

(a) A : (4) anode
B : (3) condensing magnetic lens
C : (1) objective magnetic lens
D : (2) projection magnetic lens

Cathode	A	B	Specimen	C	D	Screen

A B C D	
4 3 1 2	2A
~~3 4~~ 1 2	1A
4 3 ~~2 1~~	1A
4 ~~1 3~~ 2	1A

Many candidates were not familiar with the structure of TEM.

Q.2 Structured question

(b)(i) When an electron of mass *m* and charge *e* is accelerated from rest by a voltage *V*, show that its de Broglie wavelength λ is given by

$$\lambda = \frac{h}{\sqrt{2meV}}$$

where *h* is the Planck constant. (2 marks)

K.E. = energy gain of the electron

$$\frac{1}{2}mv^2 = eV$$ } 1M

$$(mv)^2 = 2meV$$

$$p = mv = \sqrt{2meV}$$ } 1M

Most were able to derive the formula, however, some of them did not state conservation of energy explicitly.

Q.2 Structured question

(b)(ii) The accelerating voltage of a TEM is 10 kV. Find λ. (2 marks)

$$\lambda = \frac{h}{\sqrt{2meV}}$$

$$= \frac{6.63\times10^{-34}}{\sqrt{2(9.11\times10^{-31})(1.60\times10^{-19})(10\times10^{3})}}$$ 1M

λ = 1.2279×10^{-11} m (= 0.012 nm) 1A

Most candidates substituted correct values into the formula except for some careless mistakes, such as wrong or missing units.

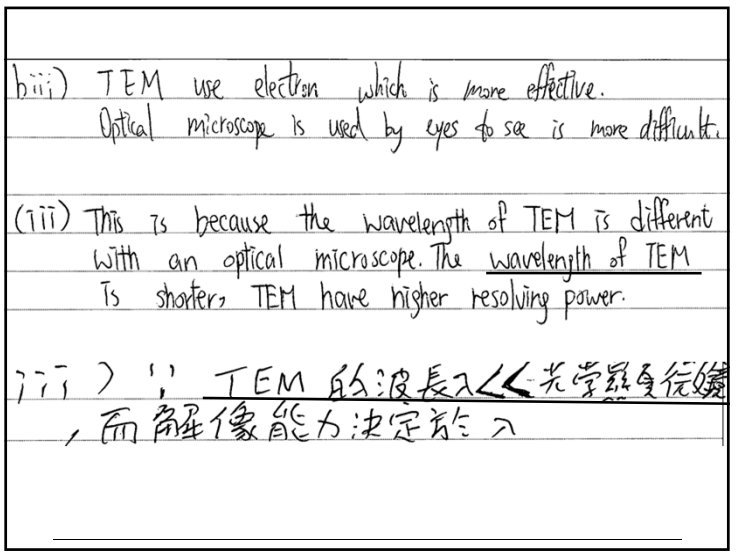
Q.2 Structured question

(b)(iii) Explain why the resolving power of a TEM is higher compared with an optical microscope. (2 marks)

Since the wavelength of the electron beam(~10^{-11} m) is shorter than that of visible light (~10^{-7} m), resolving power of a microscope, $\theta = \frac{1.22\lambda}{d}$, is greater with shorter wavelength

comparing wavelengths 1A
mentioning $\theta = \frac{1.22\lambda}{d}$ or less diffraction 1A

Many candidates knew that the wavelength of an electron is smaller than that of visible light. Weaker ones misunderstood that a larger value of θ implied higher resolving power.



Q.2 Structured question

(c) Both Scanning Tunnelling Microscopes (STM) and Transmission Electron Microscopes (TEM) have very high resolving powers. Now if the internal structure of a slice of metallic specimen is to be studied, which of the above microscopes would be suitable or are both suitable ? Explain. (2 marks)

TEM 1A
STM only reveals surface structure of specimen. 1A

Poor.
Many mixed up the features and principles of TEM and STM.

(c) 透射电子显微镜较适用。因为金属内部有大量电子，透射电子显微镜可透射电子去研究其内部。

e) 对于一片金属样本而言，只有透射电子显微镜适用研究其内部结构，因为扫描隧穿显微镜的穿透能力很高，普通金属容易被直接穿过，未来作研究内部结构之用。

(c) Both ~~suitable~~ only. TEM ~~is more~~ is suitable.

Since ~~the size of~~ the specimen is a wire and metal is a good conductor.

Paper 2

Section C : Energy and Use of Energy

Mr N.C. Leung / Mr W.K. Lee

Q.3 Multiple-choice questions

	A	B	C	D
3.1	**53.09**	21.06	20.63	5.15
3.2	5.15	3.83	**72.37**	18.41
3.3	18.83	23.86	10.29	**46.88**
3.4	29.58	7.20	**61.27**	1.89
3.5	18.71	**43.94**	17.83	19.21
3.6	18.94	15.27	38.87	**26.89**
3.7	11.56	**52.91**	8.57	26.90
3.8	**39.13**	29.87	18.89	12.05

Q.3 Multiple-choice questions

3.3 Which of the following building materials with thicknesses listed below give the best heat insulation ?

	material	thermal conductivity / W m^{-1} K^{-1}	thickness / m	
A.	concrete	0.50	0.20	(18.83%)
B.	wood	0.15	0.05	(23.86%)
C.	glass	1.00	0.04	(10.29%)
D.	**plaster**	**0.24**	**0.10**	**(46.88%)**

A : 2.5; B : 3; C : 25; D : 2.4

D : 0.24/0.1 = 2.4 (smallest)

Q.3 Multiple-choice questions

3.5 A wind turbine generator experiences wind blowing normal to it with variable speed such that the wind speed is 1 m s^{-1} for the first two minutes and 2 m s^{-1} for the third minute. What is its average power output, in W, for this period of 3 minutes if the overall efficiency of the generator is 30% and the length of each blade is 20 m ? Given : ρ = density of air in kg m^{-3}.

A. $100\pi\rho$ (18.71%)

B. $200\pi\rho$ (43.94%)

C. $600\pi\rho$ (17.83%)

D. $667\pi\rho$ (19.21%)

Q.3 Multiple-choice questions

3.5 A wind turbine generator experiences wind blowing normal to it with variable speed such that the wind speed is 1 m s^{-1} for the first two minutes and 2 m s^{-1} for the third minute. What is its average power output, in W, for this period of 3 minutes if the overall efficiency of the generator is 30% and the length of each blade is 20 m ? Given : ρ = density of air in kg m^{-3}.

$$P = \frac{P_1 \times 2 + P_2 \times 1}{3} \times 30\%$$

$$= [\frac{1}{2}\rho(\pi 20^2)(1)^3 \times 2 + \frac{1}{2}\rho(\pi 20^2)(2)^3 \times 1]/3 \times 0.3$$

$$= 200\pi\rho$$

Q.3 Multiple-choice questions

3.6 Which of the following statements about hybrid vehicles is/are correct ?

(1) The battery of a hybrid vehicle needs to be recharged by an external electric source before the vehicle can run.

(2) The power of the internal combustion engine of a hybrid vehicle is smaller than that of a conventional petrol vehicle of the same weight and performance.

(3) The primary energy source of a hybrid vehicle is 100% petrol.

A.	(1) only	(18.94%)
B.	(3) only	(15.27%)
C.	(1) and (2) only	(38.87%)
D.	**(2) and (3) only**	**(26.89%)**

Q.3 Multiple-choice questions

3.8 Under normal operation, which of the following statements about a pressurized water reactor (PWR) of a nuclear power plant is/are correct ?

(1) The coolant which carries energy away from the reactor is radioactive.

(2) The steam that drives the turbine is radioactive.

(3) The cooling water discharged into the sea from the nuclear power plant contains some radioactive substances of the reactor.

A.	**(1) only**	**(39.13%)**
B.	(3) only	(29.87%)
C.	(1) and (2) only	(18.89%)
D.	(2) and (3) only	(12.05%)

Q.3 Structure question

(a) A completely discharged battery of an electric vehicle is fully charged to store 23 kW h of energy with a terminal voltage of 220 V at an average current of 13 A. Estimate the time in hours required to fully charge the battery. Neglect the internal resistance of the battery.

(2 marks)

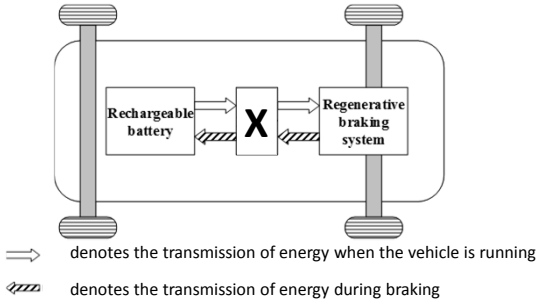
$E = VIt$

$23 \times 1000 = 220 \times 13 \times t$ 1M

$t = 8.04$ (hours) 1A

Q.3 Structure question

(b) Figure 3.1 shows the schematic diagram of an electric vehicle.



Q.3 Structure question

(b)(i) What is the function of component *X* in Figure 3.1 when the vehicle is accelerating forward? Referring to Figure 3.1, describe how the regenerative braking system saves energy during braking. (3 marks)

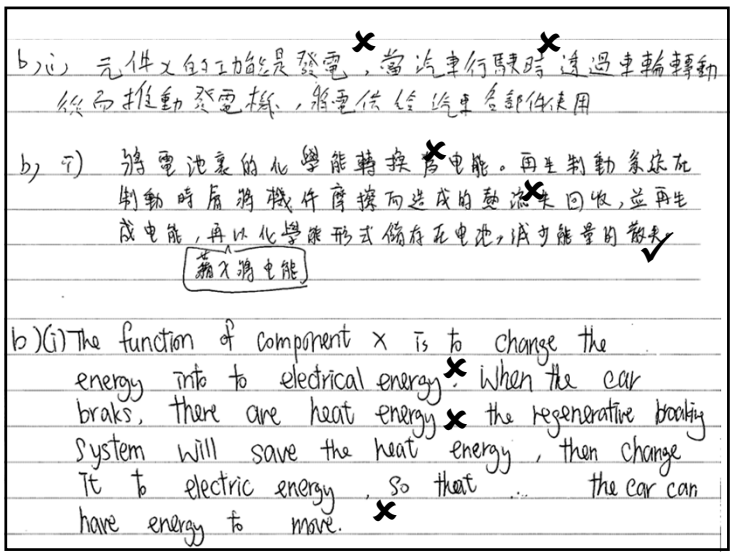
Converting electrical / energy from battery to KE / mechanical energy / force to drive the car / accelerate the car or Motor 1A
During braking, some of the kinetic energy of the wheels / vehicle is converted by the motor / generator / component *X* to electrical energy. 1A
The electrical energy is then stored in / used to charge the rechargeable battery. 1A

Q.3 Structure question

Candidates' performance

In (b)(i), many candidates did not fully understand the regenerative breaking system and the energy conversion involved.

They failed to use concise scientific terms in their answers and common misconceptions like stating that work done against friction/internal energy/heat energy were collected and then changed to electrical/chemical energy.



Q.3 Structure question

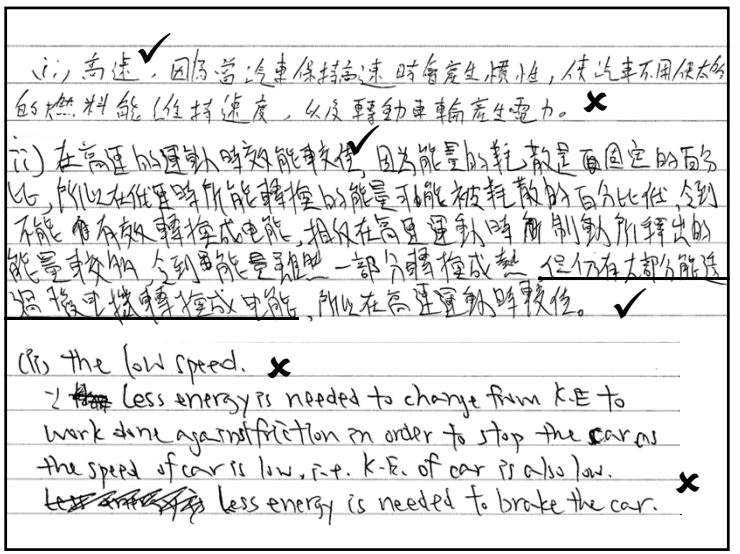
(b)(ii) Assuming that a fixed percentage of energy is dissipated into heat during braking, would the regenerative braking system be more effective when the electric vehicle is moving at a low speed or a high speed ? Explain. (2 marks)

High speed.
When braking at high speed, the amount of kinetic energy that can be converted to electrical energy (to recharge the battery) is larger.

Q.3 Structure question

Candidates' performance

Less than half of the candidates answered (b)(ii) correctly. Even for those who opted for high speed being more effective, most explanations were incorrect.


(ii) 高速，因为当汽车保持高速时会产生惯性，使汽车不用使太多的燃料能保持速度，以及驱动车轮产生动力。

(ii) 在高速的运动时效能较佳，因为能量的耗散是有固定的百分比，所以在低速时所能转换的能量到能被耗散的百分比低，会到不能有效转换成电能，相反在高速运动时刹制动所释出的能量较多会到更能量驱使一部分转换成热，但仍有大部分能源将被机械转换成电能，所以在高速运动时较佳。

(ii) the low speed.
∵ less energy is needed to change from K.E to work done against friction in order to stop the car as the speed of car is low, i.e. K.E. of car is also low.
less energy is needed to brake the car.

Q.3 Structure question

(b)(iii) Why is it necessary for an electric vehicle also be equipped with a mechanical braking system in addition to a regenerative braking system?

(1 mark)

The mechanical braking system may come into play when the regenerative braking system fails.

Q.3 Structure question

Candidates' performance

In (b)(iii), quite a number of them wrongly thought that the vehicle could not be stopped when the rechargeable battery was used up or the regenerative breaking system was not effective at high speed.

(iii) 因为再生制动系统不能提供汽车~~[illegible]~~全部的运行能量，因此需要机械制动系统填补再生系统的不足。 ✗

(b)(iii) 因为再生制动系统需在电动车制动时方可运作，配置机械制动系统可保证再生制动系统无法提供能量下运作时，电动车仍能正常运作。 ✗

(iii) Energy provided by the regenerative braking system is not enough to brake the car to stop. ✗

Q.3 Structure question

(c) Given that typical electric vehicles convert 60% of the electrical energy supplied into the vehicle's mechanical output, consider the following modes of operation of vehicles :

Mode 1	Conventional petrol vehicles : 20% of energy stored in petrol is converted to the vehicle's mechanical output.
Mode 2	Coal-fired power plants + Electric vehicles : coal-fired power plants are 45% efficient in converting energy stored in coal to electrical energy delivered at socket.
Mode 3	Nuclear power plants + Electric vehicles : nuclear power plants are 35% efficient in converting energy stored in fuel rods to electrical energy delivered at socket.

Q.3 Structure question

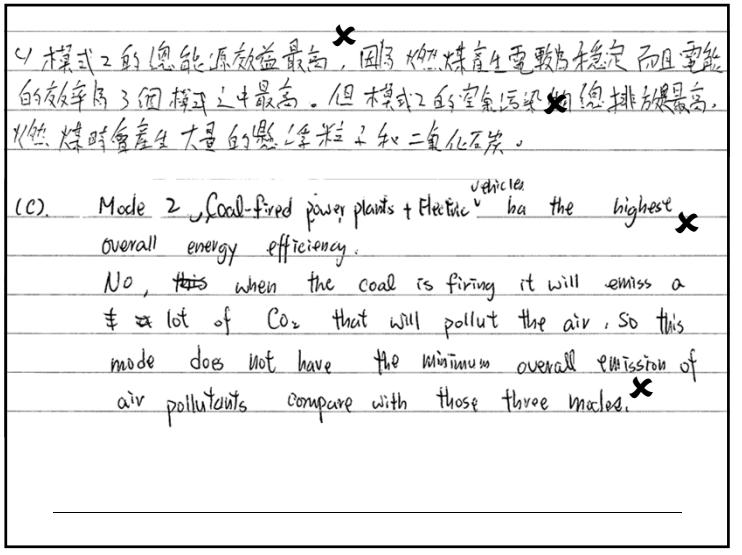
(c) Which mode has the highest **overall energy efficiency** ? Does this mode have the minimum **overall emission of air pollutants** among the three modes ? Explain your answer.

Mode 2
(overall efficiency = 45% × 60% = 27%
> 20% or 21% of the other two modes)
No. Mode 3 practically has little or no emission of air pollutants.

Q.3 Structure question

Candidates' performance

Part (c) was well answered although a few candidates did not work out the overall efficiencies and jumped to conclude that mode 2 was the most efficient. Some candidates just stated that mode 2 was not the one with minimum emission without giving explanations.



4 模式2的總能源效益最高，因為燃煤產生電數為穩定而且電能的效率為3個模式之中最高。但模式2的空氣污染物總排放量最高，燃煤時會產生大量的懸浮粒子和二氧化石炭。

(c). Mode 2 Coal-fired power plants + Electric vehicles ha the highest overall energy efficiency.

No, this when the coal is firing it will emiss a lot of CO_2 that will pollut the air, so this mode does not have the minimum overall emission of air pollutants compare with those three modes.

Paper 2

Section D: Medical Physics

HKDSE 2014

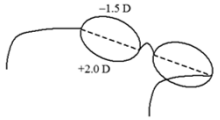
Mr M.W. Law / Mr P.C. Ying

Multiple Choice

Qn.	1	2	3	4	5	6	7	8
A	47.6%	6.3%	15.6%	21.4%	8.9%	6.22%	7.9%	56.6%
B	12.8%	28.5%	54.0%	11.3%	28.5%	31.8%	62.6%	14.4%
C	28.9%	19.2%	14.4%	62.9%	36.8%	17.7%	7.9%	20.0%
D	10.6%	45.8%	16.0%	4.33%	25.7%	44.2%	21.5%	9.0%

Qn. 4.1

4.1 Mr. Lee wears a pair of bifocal lenses as shown. The respective powers of the upper half and the lower half of each lens are −1.5 D and +2.0 D. Which of the following statements is/are correct ?



(1) The upper half is for viewing distant objects while the lower half is for viewing objects at a close distance.
(2) Mr. Lee only suffers from old sight (presbyopia).
(3) Without the spectacles, Mr. Lee cannot see an object clearly no matter how far it is placed from him.

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

A B C D ○ ○ ○ ○

Answer : A (47.6%)
Best distractor: C (28.9%)

Qn. 4.2

4.2 Which of the following statements about the threshold of hearing is/are correct ?

(1) The intensity of sound of the threshold of hearing is 0 W m^{-2}.
(2) The corresponding sound intensity level of the threshold of hearing is chosen as 0 dB.
(3) The threshold of hearing depends on the frequency of sound.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

A B C D ○ ○ ○ ○

Answer : D (45.8%)
Best distractor: B (28.5%)

Qn. 4.5

4.5 A patient is going to take a needle aspiration biopsy in which a fine needle is inserted into his liver through the skin to take a tiny living tissue for testing. In order to minimize the risk of internal bleeding, it is important to locate the large blood vessels of the liver near the place where the needle is inserted. Also, as the liver can displace slightly inside the body, real-time imaging is therefore needed during needle insertion. The most suitable imaging method is

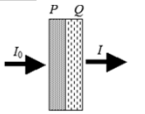
A. X-ray planar imaging.
B. computed tomography.
C. ultrasound imaging.
D. radionuclide imaging.

A B C D
○ ○ ○ ○

Answer : C (36.8%)
Best distractors: B (28.5%), D (25.7%)

Qn. 4.6

4.6 An object is made up of two different materials P and Q of 1 cm equal thickness as shown. The linear attenuation coefficients of P and Q for X-rays are 0.05 cm^{-1} and 0.68 cm^{-1} respectively. An X-ray beam of intensity I_0 is incident on the object and emerges from the object with an intensity I. Which of the following expressions gives the ratio $\frac{I}{I_0}$?



A. $\frac{0.05}{0.68}$
B. $\frac{(0.68-0.05)^2}{(0.68+0.05)^2}$
C. $e^{\frac{0.05}{0.68}}$
D. $e^{-(0.05+0.68)}$

A B C D
○ ○ ○ ○

Answer : D (44.2%)
Best distractor: B (31.8%)

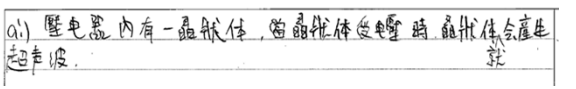
Q.4 Structural question

(a) (i) In medical imaging using ultrasound, a piezoelectric transducer is employed to scan the patient. Describe how a piezoelectric transducer generates ultrasound waves. (2 marks)

When applying a potential difference across a small block of piezoelectric crystal inside the transducer, the crystal will be distorted;	1A
it will return to its original shape if the potential difference is removed, thus ultrasound waves will be generated due to its subsequent oscillations.	1A

Many candidates failed to give concise answers in (a)(i) and stated that a current or electricity was required to distort a crystal instead of a voltage. Some did not realise that the change of voltage instead of the voltage itself makes the crystal vibrate.

Structural Question



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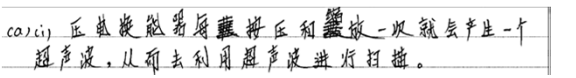

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Q.4 Structural question

(ii) State **ONE** advantage and **ONE** disadvantage of using ultrasound of higher frequencies in medical imaging. (2 marks)

Advantage : better resolution / clear	1A
Disadvantage: greater attenuation / penetrate less	1A

Part (a)(ii) was well answered although some careless candidates thought that the question asked for the advantage and disadvantage of ultrasound compares with other medical imaging methods.

Structural question

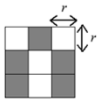
(ii) 有優點是能夠提供清晰解像度的影像。
缺點是對人體會造成一定的傷害。

1A

Q.4 Structural Question

(b) (i) John has normal eyesight and the power of his eye is +59 D in viewing distant objects. Estimate the separation between the lens and the retina of his eye. Assume that the refracting power is mainly contributed by the eye lens. (2 marks)

(ii) The display panel of a smart phone X is made up of numerous tiny square pixels as shown.



square pixels of part of the display panel

John is looking at the graphics on the display panel of smart phone X. The diameter of his eye's pupil is 4.0 mm. Estimate the resolving power θ (in radians) of his eye for graphics in green colour.
Given: wavelength of green light = 5.35×10^{-7} m. (2 marks)

Q.4 Structural question

(i) $P = \frac{1}{u} + \frac{1}{v}$ or $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ — 1M

$59 = \frac{1}{\infty} + \frac{1}{v}$

$v = 0.01695$ m (or 1.695 cm) $\approx$ 17 mm — 1A

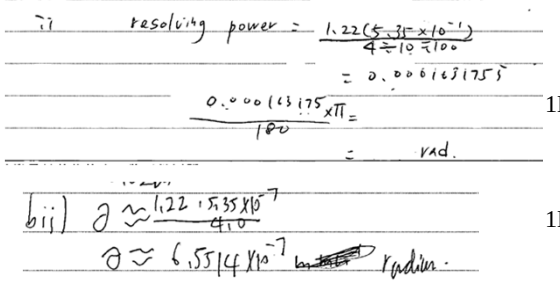
(ii) $\theta = \frac{1.22\,\lambda}{d}$

$\theta = \frac{1.22 \times 5.35 \times 10^{-7}}{4.0 \times 10^{-3}}$ — 1M

$= 1.63175 \times 10^{-4}$ (rad) $\approx 1.63 \times 10^{-4}$ (rad) — 1A

Parts (b)(i) and (ii) were well answered. However, some had difficulties in manipulating radian and made wrong or unnecessary conversion of angles.

Structural Question



1M

1M

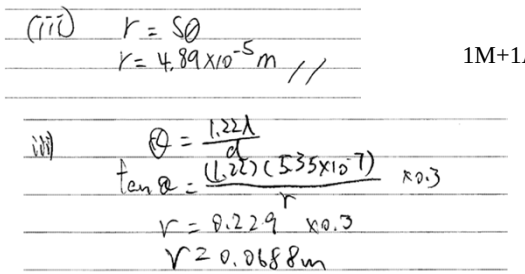
Q.4 Structural Question

(iii) The pixels of smart phone *X* are so small that the human eye is unable to distinguish two adjacent pixels at a typical viewing distance $L = 0.30$ m. Using the result of (b)(ii), estimate the maximum length of a side of a square pixel, *r*, on the display panel of smart phone *X*. You may assume that for small angle θ in radians, $\tan\theta \approx \theta$. (2 marks)

$\theta = \frac{r}{L}$ for small θ in radians	1M
$r = 1.632 \times 10^{-4} \times 0.30$ m $= 4.89525 \times 10^{-5}$ m (or 0.0489525 mm) ≈ 49.0 μm	1A

(b)(iii) was poorly answered. Many candidates had no idea about the approximation $\tan\theta \approx \theta$ when θ is small. Not many were able to apply the formula of arc length ($s = r\theta$) correctly, which should be $r = L\theta$ here. Some confused *r* in the first formula and the *r* in the question and used it in place of *L*. Some candidates wrongly used *r*/2 instead of *r*.

Structural Question



1M+1A

0

The End