SACRED HEART CANOSSIAN COLLEGE
15 – 16 S6 MOCK EXAMINATION

PHYSICS PAPER 2

Question-Answer Book

(1 hour)

This paper must be answered in English

Name: ____________________

Class & No.: _______(   )

Block: ________

INSTRUCTIONS

1. After the announcement of the start of the examination, you should first write your name, class, class number and block number in the spaces provided on Page 1 and other odd numbered pages.

2. This paper only consists of **TWO out of the FOUR** sections of the actual paper, namely Sections C and D. Each section contains eight multiple-choice questions and one-structured question, which carries 10 marks. Answer ALL questions in Sections C and D.

3. Write your answers to the structured questions on the single-lined sheets provided. Graph paper and supplementary answer sheets will be provided on request. Write your name, class, class number, and mark the question number box on each sheet.

4. For multiple-choice questions, blacken the appropriate circle with an HB pencil. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.

5. The diagrams in this paper are **NOT** necessarily drawn to scale.

6. The last pages of this Question-Answer Book contain a list of data, formulae and relationships which you may find useful.

7. No extra time will be given to candidate for writing her name or filling in the question number boxes after the 'Time is up' announcement.

Section C: Energy and Use of Energy

Q.3: Multiple-choice questions

3.1 Which of the following sentences about an electric hotplate and an induction cooker is/are correct?

(1) Both make use of the heating effect of current to cook.
(2) Both require alternating current to work properly.
(3) Both require metallic cooking utensils to work properly.

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

A ○ **B** ○ **C** ○ **D** ○

3.2 Solar constant is known to be 1366 W m^{-2}. The average radius of the Earth is 6371 km and the Sun-Earth distance is about 1.496×10^{8} km. Estimate the total radiation energy emitted by the Sun per second.

A. 2.11×10^{26} J
B. 3.84×10^{26} J
C. 3.56×10^{27} J
D. 1.67×10^{27} J

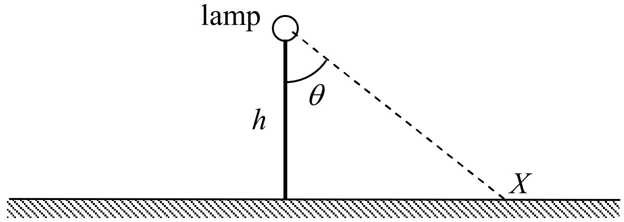
A ○ **B** ○ **C** ○ **D** ○

3.3 Which of the following best shows the parts possessed by petrol cars, electric cars and hybrid cars?

	parts	petrol cars	electric cars	hybrid cars
A.	rechargeable battery	✗	✓	✗
B.	regenerative braking system	✓	✓	✓
C.	combustion engine	✓	✗	✓
D.	motor	✗	✓	✗

A ○ **B** ○ **C** ○ **D** ○

3.4



As shown in the figure, the lamp on a post of height h can be regarded as a point light source. The illuminance on the ground at X is directly proportional to

A. $\dfrac{\cos\theta}{h}$.

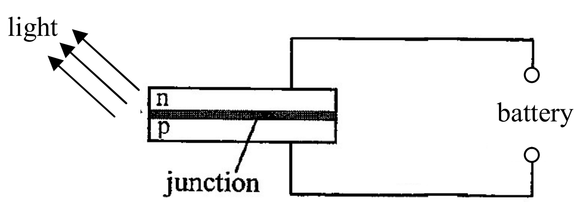
B. $\dfrac{\cos^2\theta}{h^3}$.

C. $\dfrac{\cos^3\theta}{h^2}$.

D. $\dfrac{\cos^3\theta}{h}$.

A ○ **B** ○ **C** ○ **D** ○

3.5



The above figure shows a basic LED. Which of the following is/are correct?

(1) The p-layer is connected to the positive pole of the battery.

(2) The p-layer contains excess holes and the n-layer contains excess free electrons.

(3) Electrons and holes meet at the junction and light is emitted.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

A ○ **B** ○ **C** ○ **D** ○

3.6 Which of the following statements about nuclear fission reactor is correct?

(1) Uranium nuclei split into smaller nuclei for giving out energy.

(2) Uranium-235 nuclides are used as the fuel.

(3) Pressurized water is used as moderator to slow down the reaction.

A. (1) only

B. (1) and (2) only

C. (2) and (3) only

D. (1), (2) and (3)

A ○ B ○ C ○ D ○

3.7

$$^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{1}H + ^{1}_{1}H$$

The nuclear energy released in the above reaction is 4.033 MeV. If the binding energy per nucleon of hydrogen-2 is 1.112 MeV, estimate the binding energy of hydrogen-3.

A. 4.156 MeV

B. 5.233 MeV

C. 6.902 MeV

D. 8.481 MeV

A ○ B ○ C ○ D ○

3.8 Which of the following can increase the power generated by a wind turbine?

(1) Put the wind turbine off the shore.

(2) Use longer blades.

(3) Turn the wind turbine to face the incoming wind.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

A ○ B ○ C ○ D ○

Q.3: Structured question

A small house in Figure 3.1 consists of a roof, walls and some windows. The rate of heat gain from different parts of the house on a sunny day is tabulated in Figure 3.2.

Figure 3.1

	roof	**wall**	**window**
rate of heat gain / kW	2.5	0.4	3.2
total area / m^2	160	235	20

Figure 3.2

(a) Mainly by which way is the heat from outside transferred to the house through the windows? (1 mark)

(b) Suggest a reason that the rate of heat gain from the roof is larger than that from the walls, even the wall is larger in area. (1 mark)

(c) If the thermal transmittance (U-value) of the wall is 300 W m^{-2} K^{-1}, what is the temperature difference between the interior and the exterior of the walls? (2 marks)

(d) Calculate the OTTV of the house. (2 marks)

(e) An air conditioner is installed in the house so as to remove the heat gain from outside. If the coefficient of performance of the air conditioner is 2.2, estimate the cost of electricity for using the air-conditioner for 8 hours.
(Take the cost of 1 kW h of electricity = $1.) (3 marks)

(f) Suggest a way to effectively reduce the OTTV of the house. (1 mark)

Section D: Medical Physics

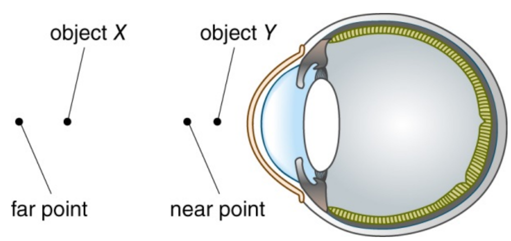
Q.4: Multiple-choice questions

4.1 The near point of Hinson's eye is at 40 cm. By wearing a corrective lens of +2D, how is his vision improved?

A. He can now see an object clearly at distance as close as 20 cm.
B. He can now see an object clearly at distance as close as 22 cm.
C. He can now see an object clearly at distance as far as 22 cm.
D. He can now see an object clearly at distance as far as 2 m.

A B C D
○ ○ ○ ○

4.2 The figure below shows a simple diagram which gives the relative positions of object *X*, object *Y*, the near point and the far point of an eye.



If the eye is looking at object *Y*, at which position does the light from object *X* and object *Y* converge to?

	Object *X*	**Object *Y***
A.	On the retina	In front of the retina
B.	Behind the retina	In front of the retina
C.	In front of the retina	Behind the retina
D.	On the retina	Behind the retina

A B C D
○ ○ ○ ○

4.3 For most people, the sound intensity level of the threshold of pain is 140 dB. What is the ratio of the intensities of this sound and the softest audible sound?

A. 21 : 1
B. 140 : 1
C. 10^{14} : 1
D. 10^{140} : 1

A B C D
○ ○ ○ ○

Class: _______ No: _____

4.4 When a sound is transmitted in the ear, the pressure on the oval window is larger than that on the eardrum. The difference is due to

(1) the smaller size of the oval window.

(2) the larger force acting on the oval window.

(3) more energy is transmitted through the oval window.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

A **B** **C** **D**

○ ○ ○ ○

4.5 Which of the following sentences about ultrasound imaging is/are correct?

(1) It involves ionizing radiation.

(2) It can detect real-time image.

(3) It is not suitable to observe air-filled organs.

A **B** **C** **D**

○ ○ ○ ○

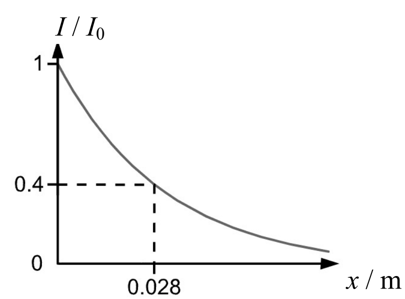
A. (1) only

B. (3) only

C. (1) and (2) only

D. (2) and (3) only

4.6



An X-ray beam of intensity I travels through a certain distance x in a muscle. The graph above shows the relation between I / I_0 and x, where I_0 is the original intensity of X-ray when it enters the muscle. Find the linear attenuation coefficient of the muscle.

A **B** **C** **D**

○ ○ ○ ○

A. 9 m^{-1}

B. 33 m^{-1}

C. 40 m^{-1}

D. 57 m^{-1}

4.7 When a patient takes a CT image, he will receive a larger radioactive dose than taking a radiographic image. Which of the following reasons are correct?

(1) The ionizing power of X-rays used in CT imaging is greater than that in radiographic imaging.

(2) The examination time of CT imaging is longer than that of radiographic imaging.

(3) The body receives more X-ray coming from different angles when the X-ray tube rotates.

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

A	B	C	D
○	○	○	○

4.8

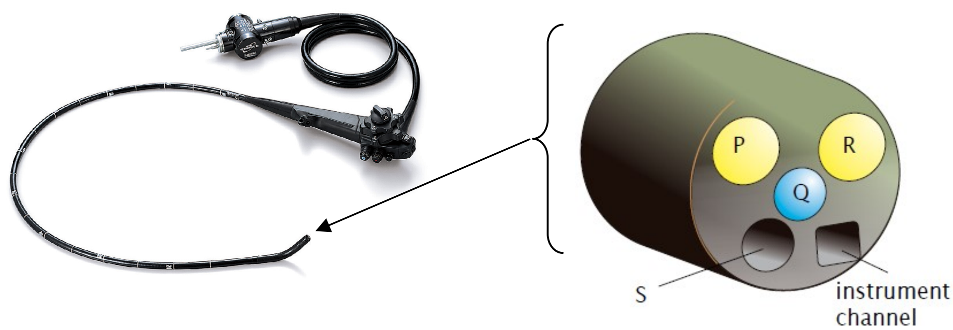
The figure above shows a radionuclide image of a patient's whole body. The grey scale of the image represents

A. the attenuation coefficient of the gamma rays.
B. the intensity of the gamma rays reflected from the boundary of the tissue.
C. the amount of the abnormal cells.
D. the concentration of the radioactive tracer.

A	B	C	D
○	○	○	○

Q.4: Structured question

The diagram shows the front end of an endoscope, where *P*, *Q*, *R* and *S* represent four channels. Channels *P* and *R* are two bundles of optical fibres for illuminating the site.



(a) (i) Briefly explain why laser is not used for illuminating the site. (1 mark)

(ii) Sometimes laser is used with an endoscope. Suggest one application of the laser. (1 mark)

(b) Channel *Q* is a coherent bundle of optical fibres. Give its use in the endoscope, and explain briefly how it works. (2 marks)

(c) Give one possible use of channel *S*, which is a hollow passage like the instrument channel. (1 mark)

(d) In an endoscopic surgery, the doctor advises a biopsy on the organ under investigation.

(i) Describe how an endoscope could be used to obtain tissue samples from organs inside a patient's body. (1 mark)

(ii) State ONE advantage of using an endoscope in this application. (1 mark)

(e) Jessica has been coughing for a long time and occasionally has blood-stained sputum.

(i) Why is endoscopy NOT suitable to investigate the lungs' condition? (1 mark)

(ii) Suggest an appropriate imaging method for Jessica. Give one advantage of using such method. (2 marks)

END OF PAPER

This is a blank page.

Answer written on this page will not be marked.

Class: _______ No: _____

Put 'X' in the box of the question number.

1	2	3	4	5	6	7	8	9	10	11	12	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
13	14	15	16	17	18	19	20	21	22	23	24	≥25

Start each question on a new page.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Put 'X' in the box of the question number.

1	2	3	4	5	6	7	8	9	10	11	12	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
13	14	15	16	17	18	19	20	21	22	23	24	≥25

Start each question on a new page.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Class: _______ No: _____

Put 'X' in the box of the question number.

1	2	3	4	5	6	7	8	9	10	11	12	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
13	14	15	16	17	18	19	20	21	22	23	24	≥25

Start each question on a new page.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Put ‘X’ in the box of the question number.

1	2	3	4	5	6	7	8	9	10	11	12	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
13	14	15	16	17	18	19	20	21	22	23	24	≥25

Start each question on a new page.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Class: _______ No: _____

List of data, formulae and relationships

Data

molar gas constant	$R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$
Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
acceleration due to gravity	$g = 9.81 \text{ m s}^{-2}$ (close to the Earth)
universal gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
speed of light in vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
charge of electron	$e = 1.60 \times 10^{-19} \text{ C}$
electron rest mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
atomic mass unit	$\text{u} = 1.661 \times 10^{-27} \text{ kg}$ (1 u is equivalent to 931 MeV)
astronomical unit	$\text{AU} = 1.50 \times 10^{11} \text{ m}$
light year	$\text{ly} = 9.46 \times 10^{15} \text{ m}$
parsec	$\text{pc} = 3.09 \times 10^{16} \text{ m} = 3.26 \text{ ly} = 206265 \text{ AU}$
Stefan constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$

Rectilinear motion

For uniformly accelerated motion :

$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

Mathematics

Equation of a straight line	$y = mx + c$
Arc length	$= r\theta$
Surface area of cylinder	$= 2\pi rh + 2\pi r^2$
Volume of cylinder	$= \pi r^2 h$
Surface area of sphere	$= 4\pi r^2$
Volume of sphere	$= \frac{4}{3}\pi r^3$

For small angles, $\sin\theta \approx \tan\theta \approx \theta$ (in radians)

Astronomy and Space Science

$U = -\frac{GMm}{r}$	gravitational potential energy
$P = \sigma A T^4$	Stefan's law
$\left\lvert\frac{\Delta f}{f_0}\right\rvert \approx \frac{v}{c} \approx \left\lvert\frac{\Delta\lambda}{\lambda_0}\right\rvert$	Doppler effect

Energy and Use of Energy

$E = \frac{\Phi}{A}$	illuminance
$\frac{Q}{t} = \kappa\frac{A(T_H - T_C)}{d}$	rate of energy transfer by conduction
$U = \frac{\kappa}{d}$	thermal transmittance U-value
$P = \frac{1}{2}\rho A v^3$	maximum power by wind turbine

Atomic World

$\frac{1}{2}m_e v_{max}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_0^2}\right\} = -\frac{13.6}{n^2} \text{ eV}$	energy level equation for hydrogen atom
$\lambda = \frac{h}{p} = \frac{h}{mv}$	de Broglie formula
$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)

Medical Physics

$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)
$\text{power} = \frac{1}{f}$	power of a lens
$L = 10\log\frac{I}{I_0}$	intensity level (dB)
$Z = \rho c$	acoustic impedance
$\alpha = \frac{I_r}{I_0} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$	intensity reflection coefficient
$I = I_0 e^{-\mu x}$	transmitted intensity through a medium

A1.	$E = mc\,\Delta T$	energy transfer during heating and cooling
A2.	$E = l\,\Delta m$	energy transfer during change of state
A3.	$pV = nRT$	equation of state for an ideal gas
A4.	$pV = \frac{1}{3}Nm\overline{c^2}$	kinetic theory equation
A5.	$E_K = \frac{3RT}{2N_A}$	molecular kinetic energy

B1.	$F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$	force
B2.	moment $= F \times d$	moment of a force
B3.	$E_P = mgh$	gravitational potential energy
B4.	$E_K = \frac{1}{2}mv^2$	kinetic energy
B5.	$P = Fv$	mechanical power
B6.	$a = \frac{v^2}{r} = \omega^2 r$	centripetal acceleration
B7.	$F = \frac{Gm_1m_2}{r^2}$	Newton's law of gravitation

C1.	$\Delta y = \frac{\lambda D}{a}$	fringe width in double-slit interference
C2.	$d\sin\theta = n\lambda$	diffraction grating equation
C3.	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	equation for a single lens

D1.	$F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$	Coulomb's law
D2.	$E = \frac{Q}{4\pi\varepsilon_0 r^2}$	electric field strength due to a point charge
D3.	$E = \frac{V}{d}$	electric field between parallel plates (numerically)
D4.	$R = \frac{\rho l}{A}$	resistance and resistivity
D5.	$R = R_1 + R_2$	resistors in series
D6.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$	resistors in parallel
D7.	$P = IV = I^2R$	power in a circuit
D8.	$F = BQv\sin\theta$	force on a moving charge in a magnetic field
D9.	$F = BIl\sin\theta$	force on a current-carrying conductor in a magnetic field
D10.	$B = \frac{\mu_0 I}{2\pi r}$	magnetic field due to a long straight wire
D11.	$B = \frac{\mu_0 NI}{l}$	magnetic field inside a long solenoid
D12.	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$	induced e.m.f.
D13.	$\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$	ratio of secondary voltage to primary voltage in a transformer

E1.	$N = N_0 e^{-kt}$	law of radioactive decay
E2.	$t_{\frac{1}{2}} = \frac{\ln 2}{k}$	half-life and decay constant
E3.	$A = kN$	activity and the number of undecayed nuclei
E4.	$\Delta E = \Delta mc^2$	mass-energy relationship