2020-S6MK

PHY

PAPER 2

SACRED HEART CANOSSIAN COLLEGE

19–20 S6 MOCK EXAMINATION

Name: _______________

Class & No.: ______(   )

Block: _____

PHYSICS PAPER 2

Question-Answer Book

(1 hour)

This paper must be answered in English

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.

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

(3) Write your answers to the structured questions on the single-lined sheets provided. 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.

(4) 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.

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

(6) The last two 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 B: Atomic World

Q.2: Multiple-choice questions

2.1 When a beam of α particles is directed towards a thin gold foil, most α particles pass thought the foil but some of them bounce back at a large angle. Which of the following can be deduced from this result?

(1) Tiny electrons orbit around a gold atom.

(2) The mass of the α particle is about the same as the gold atom.

(3) The mass in a gold atom is concentrated in a tiny core.

A. (3) only

B. (1) and (2) only

C. (1) and (3) only

D. (2) and (3) only

A B C D
○ ○ ○ ○

2.2 According to Bohr's model, the electron in a hydrogen atom

A B C D
○ ○ ○ ○

A. can orbit at any distance from the nucleus.

B. can escape from the atom by emitting a photon.

C. emits electromagnetic wave when it stays in a certain orbit.

D. releases energy when it moves from a large orbit to a small orbit.

2.3 Which of the following phenomena about photoelectric effect **CANNOT** be explained by classical physics?

(1) Photoelectrons are emitted from the metal surface almost instantaneously upon the shine of light.

(2) No photoelectron can reach the collector in a photocell if the potential difference between the electrodes exceeds the stopping potential.

(3) No photoelectron will be emitted if the frequency of the light is too low.

A B C D
○ ○ ○ ○

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

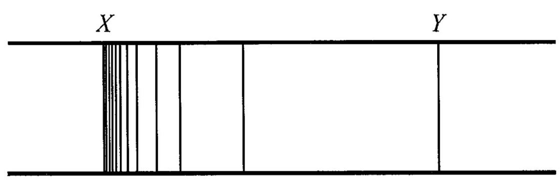
D. (1), (2) and (3)

2.4 A hydrogen is excited from the first excited state (n = 2) to the third excited state (n = 4) when it absorbs energy E. What is the energy required to excite a hydrogen atom from the third excited state (n = 4) to the seventh excited state (n = 8)?

A. E / 2
B. E / 4
C. E / 16
D. E / 64

A ○ **B** ○ **C** ○ **D** ○

2.5



The figure above shows all the spectral lines emitted by a hydrogen atom from any excited state to the ground state (n = 1). Which of the following is/are correct?

(1) Theoretically, there are infinitely many spectral lines between X and Y.
(2) X has a higher frequency than Y.
(3) A hydrogen atom will be ionized if it absorbs a photon corresponding to Y.

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

A ○ **B** ○ **C** ○ **D** ○

2.6 In a transmission electron telescope (TEM), electrons are accelerated by a potential difference of 2 V. Estimate the de Broglie wavelength of those electrons.

A. 0.868 nm
B. 1.03 nm
C. 3.41 nm
D. 18.7 nm

A ○ **B** ○ **C** ○ **D** ○

2.7 An artificial satellite, located at 4000 km above the ground, has a telescope with an aperture of 20 cm. Estimate the smallest distance between two trees resolvable by this telescope. Assume the trees emit light of wavelength 500 nm.

A. 1 m
B. 5 m
C. 12 m
D. 28 m

A ○ **B** ○ **C** ○ **D** ○

2.8 Some people coat a nano-sized layer of titanium dioxide on a sheet of glass. Which of the following is **NOT** the purpose of the coating?

A. UV blocking
B. self-cleaning
C. water repelling
D. breaking down organic dirt

A ○ **B** ○ **C** ○ **D** ○

Q.2: Structured question

As shown in Figure A, a photocell is connected to a d.c. power supply. The cathode in the photocell is illuminated by blue light of 480 nm. The intensity of the light is 0.04 W m^{-2}.

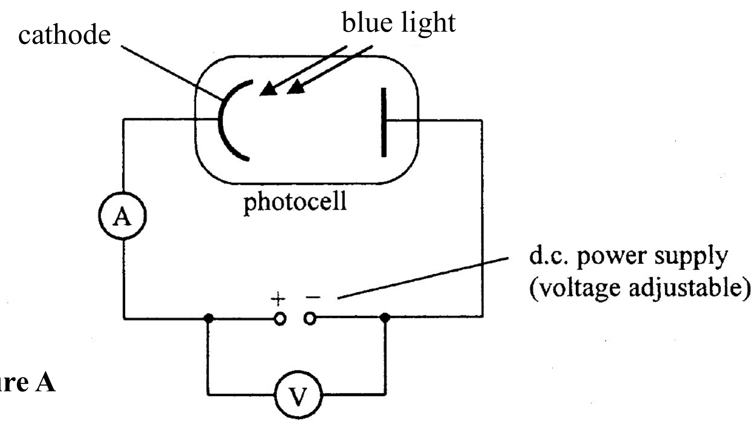
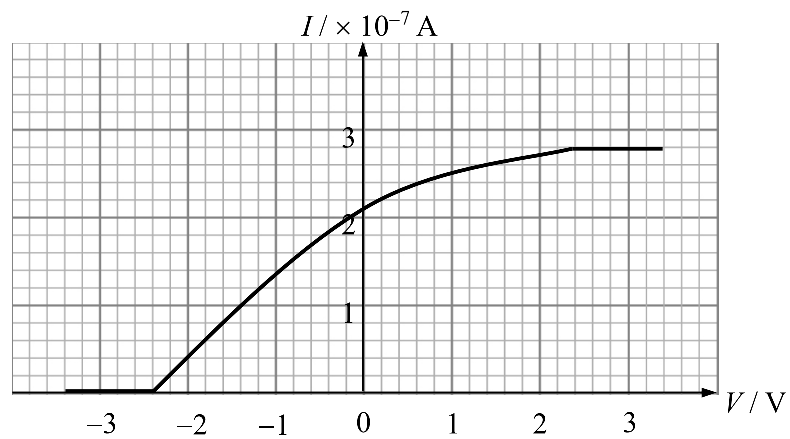


Figure A

By adjusting the voltage of the power supply, Figure B is obtained to show how the photoelectric current I varies with the potential difference V across the photocell.

Figure B



(a) From the graph, calculate the number of photoelectrons emitted by the cathode per second. (2 marks)

(b) (i) Find the energy of each photon in the blue light. (2 marks)

(ii) If the area of the cathode receiving the blue light is 1×10^{-4} m^2, estimate the number of photons hitting the metal plate per second. (2 marks)

(c) From the graph, find the work function of the metal. (2 marks)

(d) If the same blue light of higher intensity is used, sketch the corresponding curve in Figure B. (2 marks)

Section C: Energy and Use of Energy

Q.3: Multiple-choice questions

3.1 A 1000-W microwave oven can heat 1.05 kg of soup from 20°C to 70°C in 5 minutes. Estimate the end-use efficiency of the microwave oven.

Given: specific heat capacity of the soup = 4000 J kg^{-1} $°C^{-1}$

A. 62.5%
B. 66.7%
C. 70%
D. 77.8%

A B C D
○ ○ ○ ○

3.2 Which of the following statements about some major components of an air conditioner is correct?

A. The compressor increases the temperature of the refrigerant.
B. The expansion valve turns part of the refrigerant from gas to liquid.
C. When the refrigerant passes through the condensing coil, it absorbs heat from the air in the room.
D. When the refrigerant passes through the evaporator coil, it absorbs heat from the air outside the room.

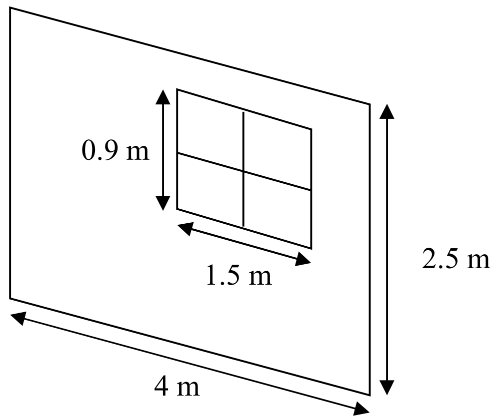
A B C D
○ ○ ○ ○

3.3 In a fluorescent lamp, visible light is emitted from

A. argon gas.
B. mercury vapour.
C. phosphor coating.
D. the electrodes.

A B C D
○ ○ ○ ○

3.4 The figure below shows a concrete wall with a glass window on it. The concrete wall is 20 cm thick. The U-values of the concrete and the glass are 4 W m^{-2} K^{-1} and 1.3 W m^{-2} K^{-1} respectively. Find the average U-value of this wall.



A. 0.868 W m^{-2} K^{-1}
B. 2.65 W m^{-2} K^{-1}
C. 3.34 W m^{-2} K^{-1}
D. 3.64 W m^{-2} K^{-1}

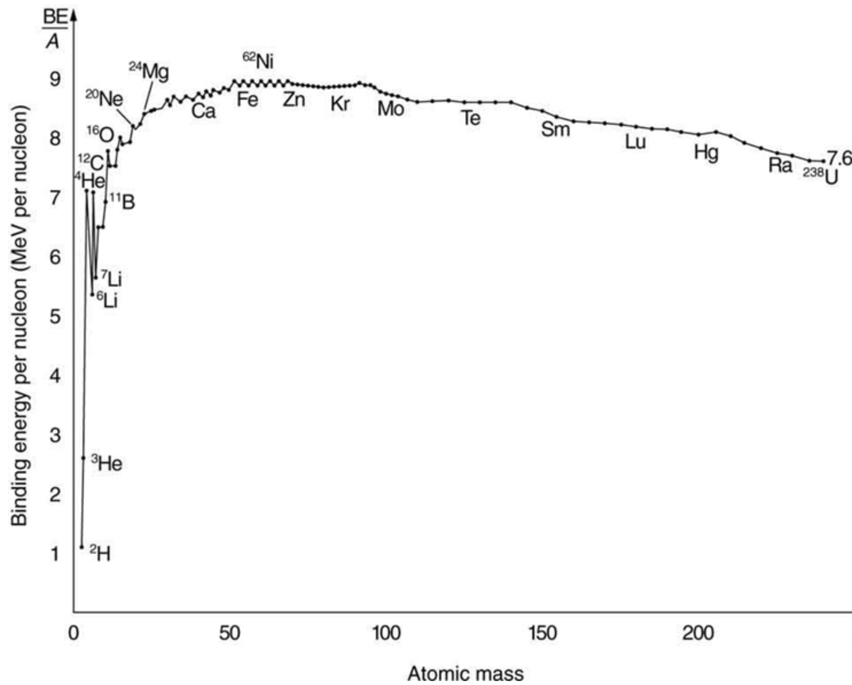
A ○ B ○ C ○ D ○

3.5 Which of the following statements about hybrid vehicles is/are correct?
(1) Comparing to electric vehicles, hybrid vehicles have higher end-use efficiency.
(2) Comparing to fossil-fuel vehicles, hybrid vehicles have longer range.
(3) Some hybrid vehicles do not need external source to charge the batteries.

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

A ○ B ○ C ○ D ○

3.6 The graph below shows the binding energy per nucleon of different nuclides.



According to the graph, which of the following interpretations is **NOT** correct?

A. Energy is released when magnesium (Mg) is formed by nuclear fusion.

B. Iron (Fe) has the most binding energy among all nuclides.

C. More energy is required to split mercury (Hg) than tellurium (Te) into their individual nucleons.

D. Energy is released when uranium (U) splits into two nuclides of similar mass.

A ○ **B** ○ **C** ○ **D** ○

3.7 A wind turbine is set to rotate when wind blows normally at 14 m s^{-1}. If the blades are 4.5 m long and the overall efficiency is 20 %, estimate the output power of the wind turbine.

Given: density of air = 1.2 kg m^{-3}

A. 1.50 kW

B. 20.9 kW

C. 29.3 kW

D. 33.5 kW

A ○ **B** ○ **C** ○ **D** ○

3.8 Which of the following statements are correct when a solar cell is exposed to sunlight?

(1) A direct current is produced.

(2) Free electrons move to the n-side of the solar cell.

(3) An electric field is developed in the PN junction.

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

The table below shows some information of two lamps.

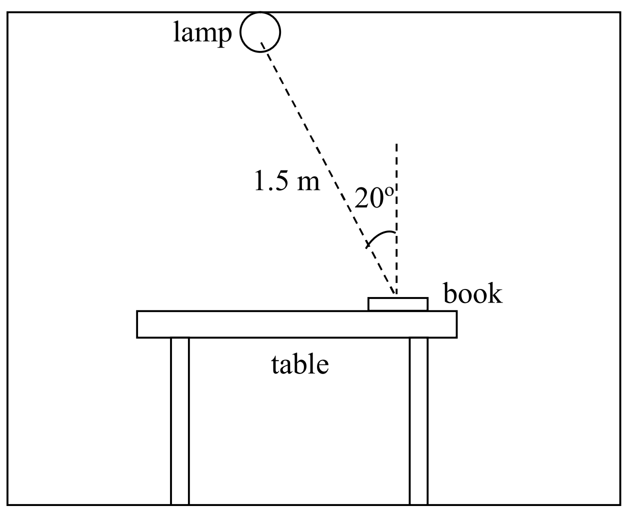
Type of lamp	**Average lifetime / h**	**Power / W**	**Efficacy / lm W^{-1}**	**Price / $**
LED lamp	12500	50	40	110
Incandescent lamp	2200	100	20	50

(a) (i) Are the two lamps equally bright to human eyes? Explain your answer. (2 marks)

(ii) The cost of electricity is $1.2 per kW h. How much can be saved if the LED lamp is used instead of the incandescent lamp for 10 years? Assume that on average the lamp is switched on for 12 hours per day. (2 marks)

(iii) Except the cost, suggest **ONE** advantage and **ONE** disadvantage of using the LED lamp over the incandescent lamp. (2 marks)

(b) The figure below shows a room with the incandescent lamp installed at the ceiling. Assume that the incandescent lamp is a point source of light.



(i) Estimate the illuminance of a book placed horizontally on a table 1.5 m away from the incandescent lamp, with the light incident at an angle 20° to vertical. State **ONE** assumption in your calculation. (3 marks)

(ii) It is found that the illuminance on the book is too low for reading. With the same lamp, suggest **ONE** feasible way to increase the illuminance on the book. (1 mark)

END OF PAPER

List of data, formulae and relationships

Data

molar gas constant	$R = 8.31$ J mol^{-1} K^{-1}
Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}
acceleration due to gravity	$g = 9.81$ m s^{-2} (close to the Earth)
universal gravitational constant	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}
speed of light in vacuum	$c = 3.00 \times 10^8$ m s^{-1}
charge of electron	$e = 1.60 \times 10^{-19}$ C
electron rest mass	$m_e = 9.11 \times 10^{-31}$ kg
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2}
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}
atomic mass unit	u = 1.661×10^{-27} kg (1 u is equivalent to 931 MeV)
astronomical unit	AU = 1.50×10^{11} m
light year	ly = 9.46×10^{15} m
parsec	pc = 3.09×10^{16} m = 3.26 ly = 206265 AU
Stefan constant	$\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}
Planck constant	$h = 6.63 \times 10^{-34}$ 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
$P = \sigma AT^4$	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
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_0^2}\right\} = -\frac{13.6}{n^2}$ 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)
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