2019-S6MK

PHY

PAPER 1A

SACRED HEART CANOSSIAN COLLEGE

18 – 19 S6 MOCK EXAMINATION

PHYSICS PAPER 1

Time allowed: 2 hours 30 minutes

This paper must be answered in English

GENERAL INSTRUCTIONS

1. There are **TWO** sections, A and B, in this Paper. You are advised to finish Section A in about 50 minutes.
2. Section A consists of multiple-choice questions in this question paper, while Section B contains conventional questions printed separately in Question-Answer Book **B**.
3. Answers to Section A should be marked on the Multiple-choice Answer Sheet while answers to Section B should be written in the spaces provided in the Question-Answer Book **B**. **The Answer Sheet for Section A and the Question-Answer Book for Section B will be collected separately at the end of the examination.**
4. The diagrams in this paper are **NOT** necessarily drawn to scale.
5. The last two pages of this question paper contain a list of data, formulae and relationships which you may find useful.

INSTRUCTIONS FOR SECTION A (MULTIPLE-CHOICE QUESTIONS)

1. Read carefully the instructions on the Answer Sheet. After the announcement of the start of the examination, you should write your name and insert the information required in the spaces provided. No extra time will be given for writing the information after the 'Time is up' announcement.
2. When told to open this book, you should check that all questions are there. Look for the words **'END OF SECTION A'** after the last question.
3. All questions carry equal marks.
4. **ANSWER ALL QUESTIONS.** You are advised to use an HB pencil to mark all the answers on the Answer Sheet, so that wrong marks can be completely erased with a clean rubber. You must mark the answers clearly; otherwise you will lose marks if the answers cannot be captured.
5. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.
6. No marks will be deducted for wrong answers.

Not to be taken away before the end of the examination session

Section A

There are 33 questions. Questions marked with * involve knowledge of the extension component.

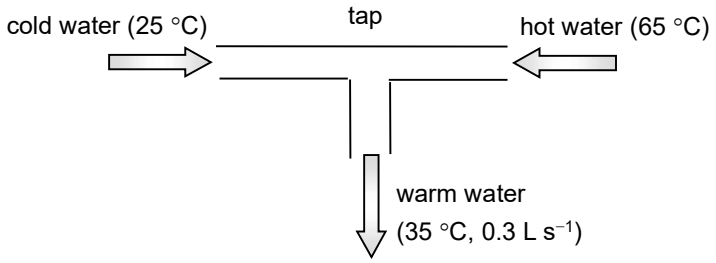
1. A microwave oven is used to heat up 0.2 kg of water at 20 °C. Energy is transferred to the water at a constant rate of 800 W. How long does it take to boil away all the water in the glass?
(The specific latent heat of vaporization of water is $2260\,\text{kJ kg}^{-1}$. The specific heat capacity of water is $4200\,\text{J kg}^{-1}\,\text{°C}^{-1}$.)

   A. 84 s
   B. 565 s
   C. 649 s
   D. 724 s

2. The separation between the −10 °C and 110 °C marks on a mercury-in-glass thermometer is 20 cm. When the thermometer is put in a liquid of temperature *T*, the mercury thread is 10 cm above the 0 °C mark. The temperature *T* is

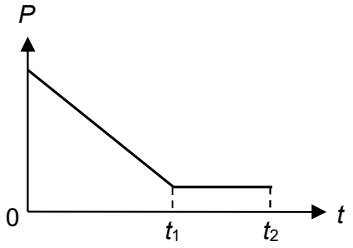
   A. 50 °C.
   B. 55 °C.
   C. 58 °C.
   D. 60 °C.

3. As shown below, hot water at 65 °C and cold water at 25 °C are mixed before leaving the tap. Suppose the water leaving the tap is at 35 °C and flows at a rate of $0.3\,\text{L s}^{-1}$. What is the rate at which the hot water flows into the tap?



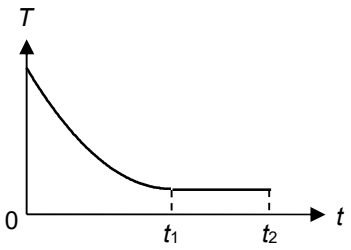
   A. $0.075\,\text{L s}^{-1}$
   B. $0.092\,\text{L s}^{-1}$
   C. $0.138\,\text{L s}^{-1}$
   D. $0.150\,\text{L s}^{-1}$

4. A liquid is heated at power P which changes with time t as shown.

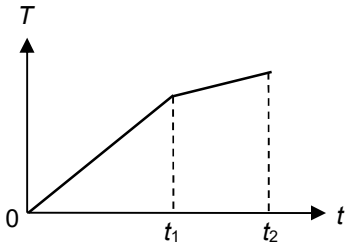


Assume that the liquid does not change to gas until $t = t_2$. Which of the following graphs best shows the variation of the temperature T of the liquid with time t?

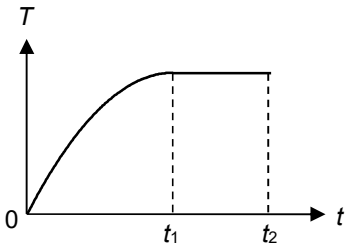
A.



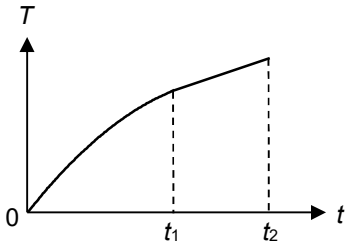
B.



C.



D.



*5. Two vessels X and Y, which contain the same kind of ideal gas at the same temperature, are connected by a tap which is initially closed. The volume and pressure of the gas in the vessels are listed as follows:

Vessel	Pressure / Pa	Volume / m^3
X	4×10^5	1.3×10^{-2}
Y	3×10^5	7×10^{-3}

When the tap is opened, what will be the final pressure in the vessels if the volumes of the vessels and the temperature of the gas are constant throughout the process?

A. 3.42×10^5 Pa
B. 3.50×10^5 Pa
C. 3.65×10^5 Pa
D. 3.83×10^5 Pa

6. Which of the following about a uniformly accelerating object MUST be correct?

(1) The object is speeding up.

(2) The velocity of the object is changing.

(3) The object is moving in the same direction.

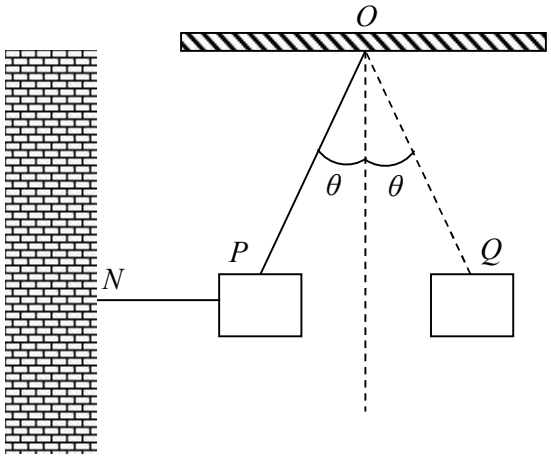
A. (1) only

B. (2) only

C. (1) and (3) only

D. (2) and (3) only

7. A block of mass m is held at rest at P by a string OP making an angle θ with the vertical and a horizontal string NP as shown in the figure below. The tension in OP is T_P. When the string NP is cut, the block will swing to position Q where OQ also makes an angle θ with the vertical. The tension in OP is T_Q. Which of the following gives the values of T_P and T_Q.



	T_P	T_Q
A.	$\frac{mg}{\cos\theta}$	$mg\cos\theta$
B.	$\frac{mg}{\cos\theta}$	$\frac{mg}{\cos\theta}$
C.	$mg\cos\theta$	$\frac{mg}{\cos\theta}$
D.	$mg\cos\theta$	$mg\cos\theta$

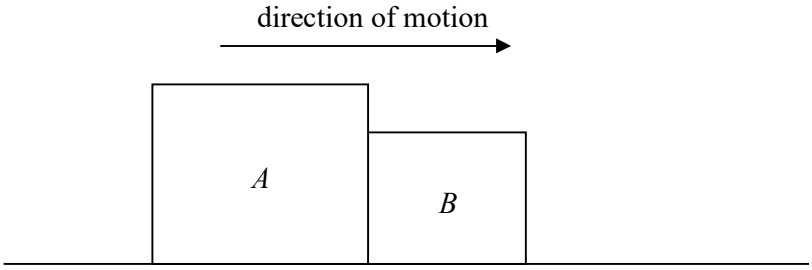
8. Two blocks, A and B, of mass 3 kg and 2 kg respectively, are moving together on a rough horizontal surface as shown in the figure below. The friction acting on each block is 2 N. Find the force acting on A by B.

A. 2 N

B. 0.8 N

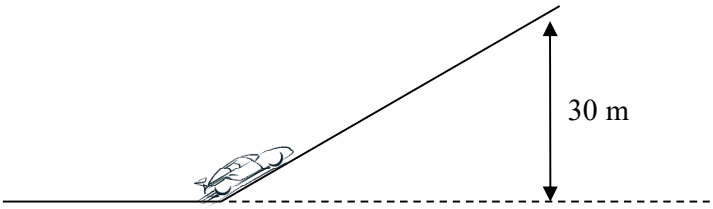
C. 0.4 N

D. 0 N



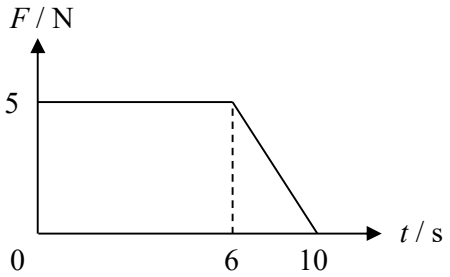
9. A car of mass 1000 kg is moving up a slope from rest. The car arrives at the top of the slope, which is 30 m from the ground level, with a speed of 10 m s^{-1} in 40 s. Find the average power output of the car. Neglect air resistance and friction.

A. 8610 W
B. 7360 W
C. 6349 W
D. 1250 W



10. A bob of mass 4 kg is originally moving at 6 m s^{-1} towards the *left*. It experiences a force *F* pushing it towards the *right* for 10 s. The variation of the force *F* and time *t* is shown in the graph below. What is the speed of the bob after 10 s?

A. 16 m s^{-1}
B. 12 m s^{-1}
C. 8 m s^{-1}
D. 4 m s^{-1}



*11. A ball is projected horizontally from the top of a building at 20 m s^{-1}. Assume that there is no air resistance. What is its vertical speed 5 s later?

A. 20 m s^{-1}
B. 49.1 m s^{-1}
C. 100 m s^{-1}
D 223 m s^{-1}

*12. A projectile is projected with speed v at an angle 30^{o} above the horizontal, and its kinetic energy is E. Express the kinetic energy of the projectile in terms of E when it is at one-third of its maximum height of flight.

A. $\frac{5}{6}E$

B. $\frac{25}{36}E$

C. $\frac{11}{12}E$

D. $\frac{121}{144}E$

*13. A satellite turns around a planet in a circular orbit with period T. If the distance between the satellite and the centre of the planet is three times its original value, the period will become

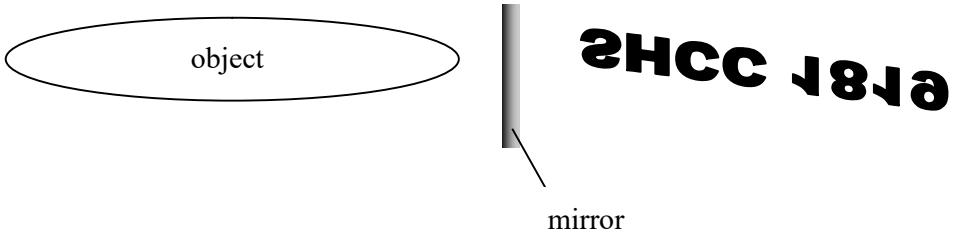
A. T

B. $3T$

C. $5.20T$

D. $9T$

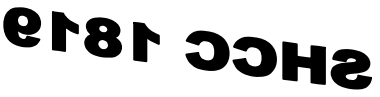
14. The figure below shows the image formed in a plane mirror.

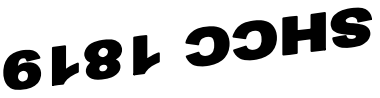


Which of the following correctly shows the object?

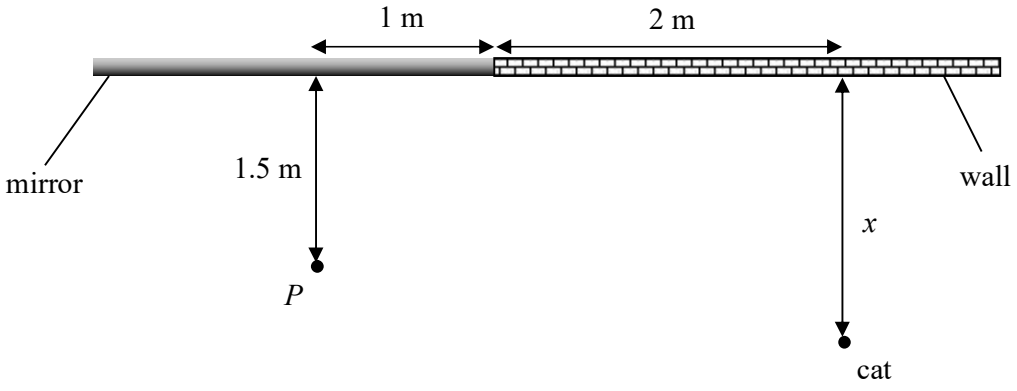
A. 

B. 

C. 

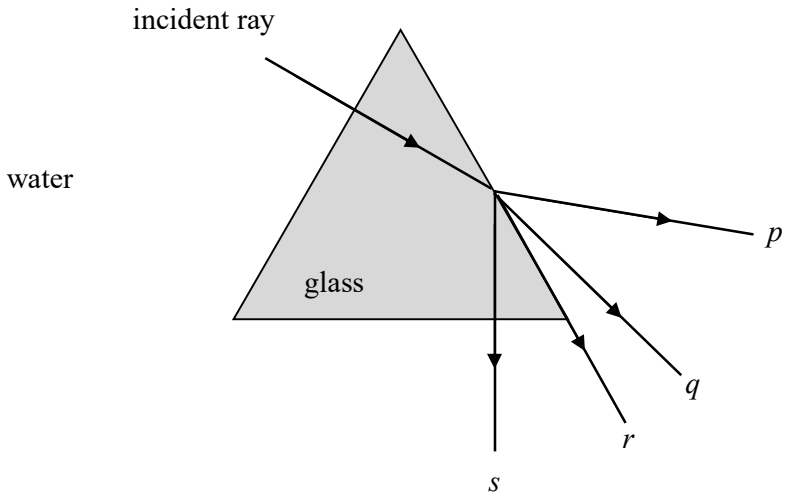
D. 

15. Ken is standing at *P* looking at the image of a cat standing *x* m in front of a wall as shown in the figure below. What is the limit of *x* for the image of the cat to be seen by Ken?



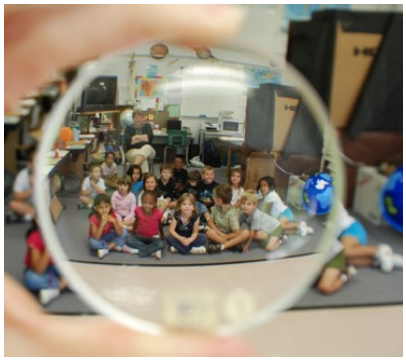
A. at least 3 m
B. at most 3 m
C. at least 1.5 m
D. at most 1.5 m

16. A light ray is incident on a equilateral triangular glass prism (refractive index 1.6) immersed in water (refractive index 1.33) as shown in the figure below. Which light ray best represents the emergent ray?



A. *p*
B. *q*
C. *r*
D. *s*

17. The figure below shows an image when viewing through a spherical lens.

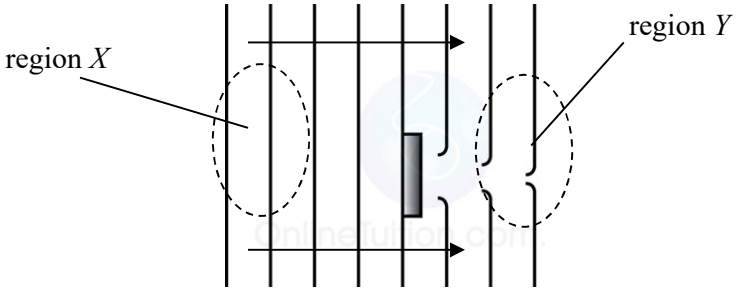


Which of the following statements are INCORRECT?

(1) The lens used is convex lens.
(2) The image is real, upright and diminished.
(3) The image can be formed on a screen.

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

18. The figure below shows a water wave travelling to the right in a water tank of uniform depth. It is diffracted when it passes an obstacle.

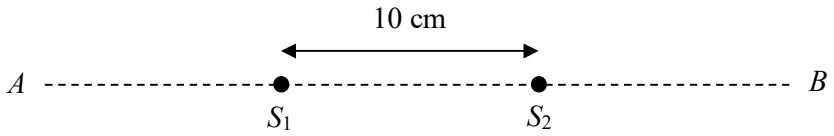


Which of the following physical quantities of the water waves in regions *X* and *Y* are the same?

(1) wave speed
(2) amplitude
(3) frequency

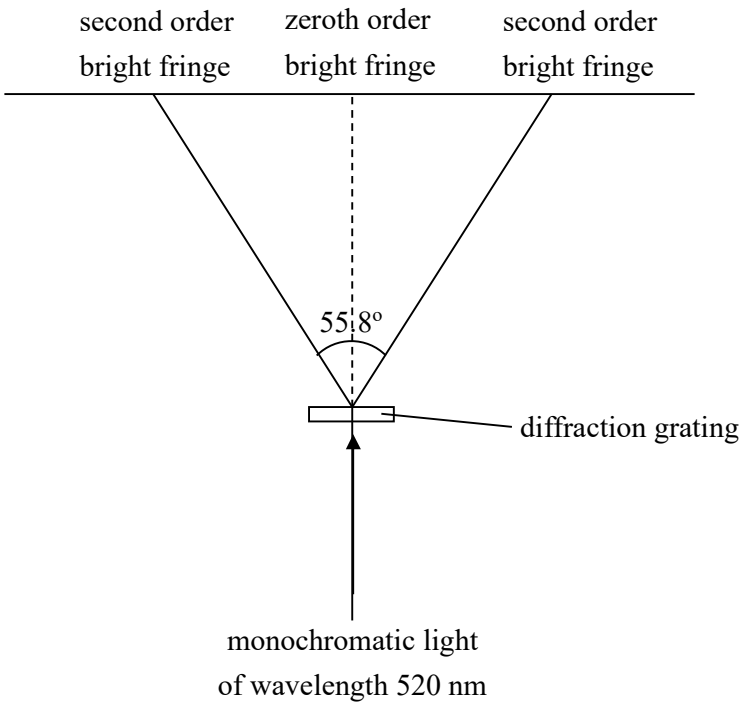
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

19. The figure below shows two coherent sources, S_1 and S_2, separated by 10 cm. They are vibrating at 2.5 Hz and producing water wave of speed 5 cm s^{-1}. *AB* is a line joining S_1 and S_2. How many points of zero displacement can be found along *AB*?



A. 4
B. 6
C. 8
D. 10

20. A monochromatic light of wavelength 520 nm is incident normally on a diffraction grating of y lines per mm as shown in the figure below. The angle subtended by the two second order bright fringes is 55.8°. Find the value of y.

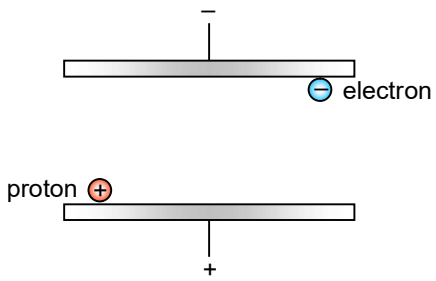


A. 225
B. 398
C. 450
D. 795

21. Which of the following about audible sound and ultrasound MUST be correct?
(1) Both ultrasound and audible sound are longitudinal waves.
(2) Ultrasound has higher frequency than audible sound.
(3) Ultrasound carries more energy than audible sound.

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

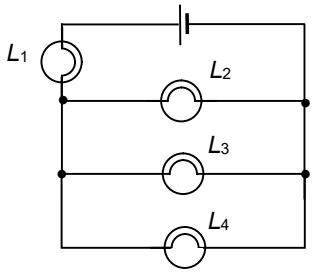
22. A proton and an electron are placed between two parallel charged plates as shown. Initially, the proton is at rest at the positive plate (lower plate) and the electron is at rest at the negative plate (upper plate). Neglect the effect of gravity and the electrostatic forces between the proton and the electron. Which of the following statements is/are correct when the proton and the electron reach the opposite plates?



(1) The momentum of the electron is larger in magnitude than that of the proton.
(2) The electron has a smaller speed than the proton.
(3) The electron and the proton have equal kinetic energy.

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

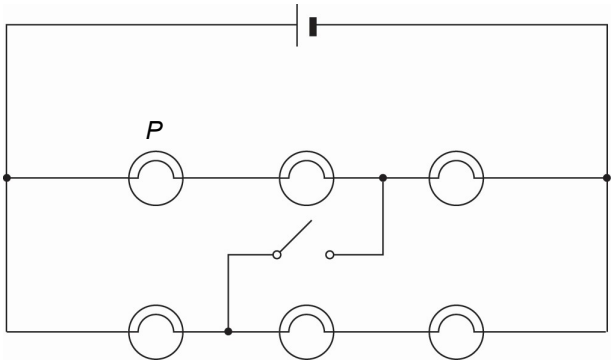
23. Four identical lamps are connected as shown. Assume the internal resistance of the dry cell is negligible.



If the filament in L_3 is burnt, which of the following will happen?
(1) L_1 becomes dimmer.
(2) L_2 becomes dimmer.
(3) L_4 becomes brighter.

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

24. Six identical light bulbs are connected as shown. The internal resistance of the dry cell is negligible.



When the switch is open, the potential difference across bulb P is V_o. What is the potential difference across bulb P when the switch is closed?

A. $0.5V_o$
B. $0.75V_o$
C. V_o
D. $1.5V_o$

25. A kettle operating at 1200 W takes 15 minutes to boil 3 kg of water.

Suppose electrical energy costs \$1.1 per kW h. Estimate the cost of boiling 1-kg water by this kettle.

A. \$ 0.09
B. \$ 0.11
C. \$ 0.33
D. \$ 0.99

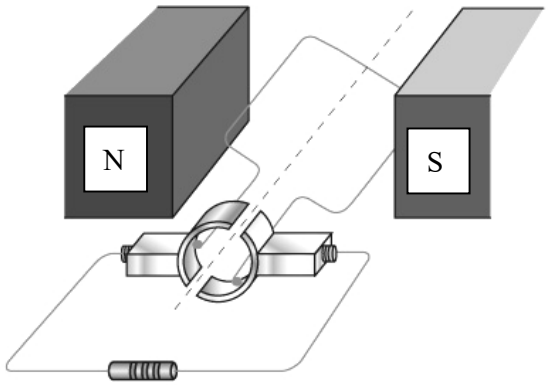
26. A kettle of rated value '220V, 1500W' is connected to a sinusoidal a.c. power supply. If the average power consumption of the kettle is 1000 W, find the peak value of the voltage across the kettle.

A. 127 V
B. 180 V
C. 194 V
D. 254 V

*27. A transformer works at an efficiency of 80%. The primary voltage is 100 V and the turns ratio is 20 : 1. If the resistance of the secondary circuit is 50 Ω, what is the primary current?

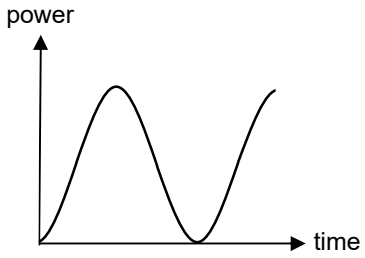
A. 5 mA
B. 6.25 mA
C. 10 mA
D. 2 A

28. In the generator shown below, the coil rotates at a constant speed. A resistor is connected to the generator.

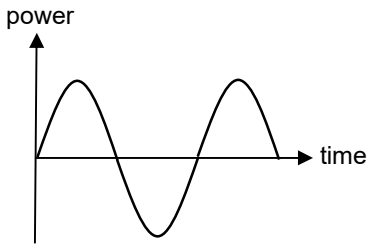


Which of the following graphs best shows the power dissipated in the resistor?

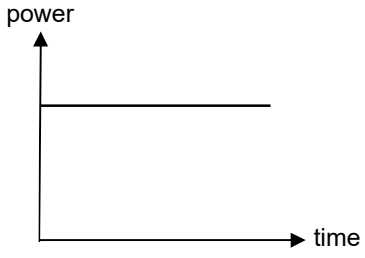
A.



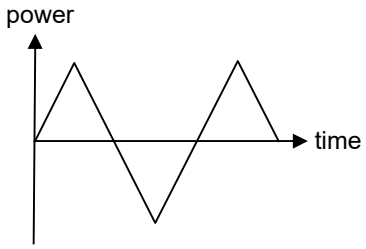
B.



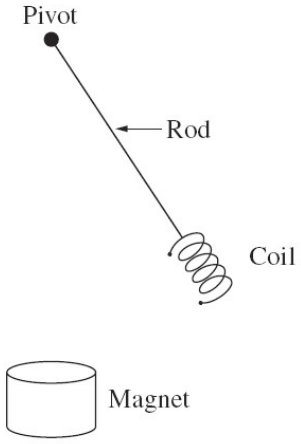
C.



D.



29. A light rod has a coil of insulated copper wire fixed at one end and is pivoted at the other end. The result is a pendulum which is free to swing back and forth. A magnet is placed underneath this pendulum. The arrangement is shown in the diagram. The pendulum is pulled back and then allowed to swing. If air resistance is negligible, which of the following would cause the pendulum to come to rest most quickly?



A. Replacing the magnet with a stronger one
B. Shortening the pendulum
C. Replacing the rod with a heavier one
D. Connecting the ends of the coil by a piece of copper wire

30. Two straight metal rods, P and Q, have the same length. They are each pivoted at one end and rotated with the same angular velocity so that they sweep out horizontal circular paths as shown in diagrams X and Y. A constant current I is flowing along each rod as shown. In diagram X, a constant magnetic field is applied perpendicular to the plane of the circular path. In diagram Y, a uniform magnetic field of the same magnitude is applied in the plane of the circular path.

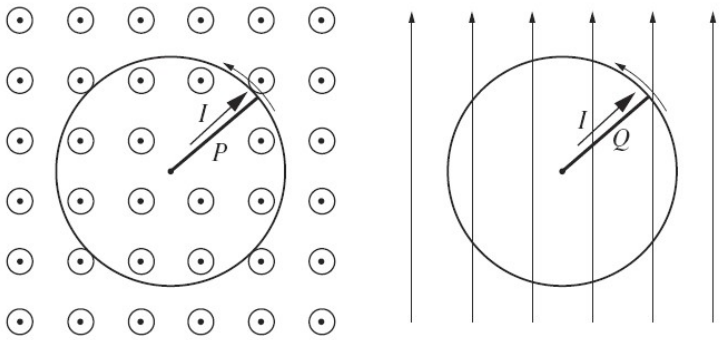
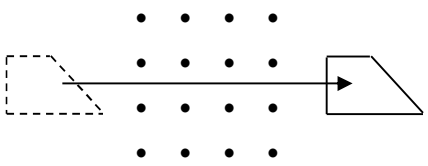


Diagram X Diagram Y

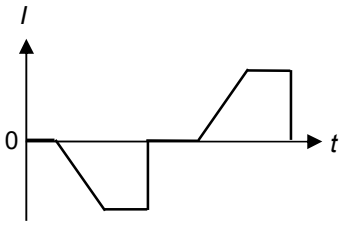
Which of the following statements about the forces acting on rod P and rod Q is correct?

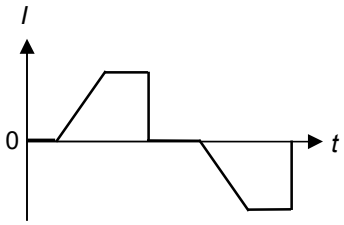
A. The magnitude of the magnetic force on P is exactly the same as the magnitude of the magnetic force on Q at all times.
B. The magnitude of the magnetic force on P is constant and the magnitude of the magnetic force on Q is zero.
C. The magnitude of the magnetic force on P is constant and the magnitude of the magnetic force on Q varies with time.
D. The magnitude of the magnetic force on P varies with time and the magnitude of the magnetic force on Q is constant.

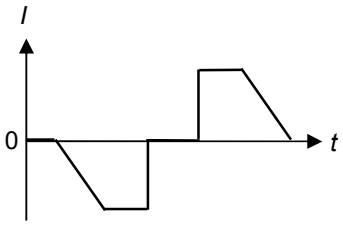
31. In the following figure, a trapezium-shaped metal coil moves at a constant velocity across a uniform magnetic field pointing out of page.

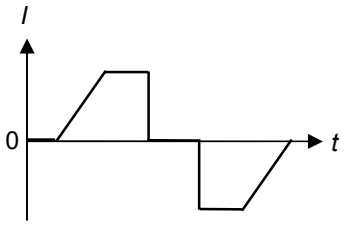


Which of the following graphs best shows the variation of the induced current I in the coil with time t? The clockwise direction is taken as positive.

A.


B.


C.


D.


*32. The fission of one atom of uranium-235 (U-235) generates 202.5 MeV of energy. Suppose that a power plant consumes 0.5 kg of U-235 each hour and its efficiency in converting the nuclear energy into electrical energy is 30%. Estimate its power output. Given: molar mass of U-235 = 235 g

A. 1.24 GW
B. 3.46 GW
C. 6.92 GW
D. 11.5 GW

*33. The decay constant of a radioactive sample is $3 \times 10^{-4}\ s^{-1}$. The sample initially consists of 99% of undecayed nuclides. How long does it take for the percentage of the undecayed nuclides in the sample to decrease to 1%?

A. 38.5 minutes
B. 4.17 hours
C. 4.25 hours
D. 62.9 hours

END OF SECTION A

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
$\left\|\frac{\Delta f}{f_0}\right\| \approx \frac{v}{c} \approx \left\|\frac{\Delta\lambda}{\lambda_0}\right\|$	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.	$N = N_0e^{-kt}$	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

2019-S6MK

PHY

PAPER 1B

B

SACRED HEART CANOSSIAN COLLEGE

18 – 19 S6 MOCK EXAMINATION

PHYSICS PAPER 1

Section B: Question-Answer Book B

This paper must be answered in English

INSTRUCTIONS FOR SECTION B

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. Refer to the general instructions on the cover of the Question Paper for Section A.
3. Answer **ALL** questions.
4. Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.
5. Supplementary answer sheets will be provided on request. Write your name, class, class number, and mark the question number box on each sheet.
6. No extra time will be given to candidates for filling in the question number boxes after the 'Time is up' announcement.

Name: _____

Class & No.: _____( )

Block: _____

Question No.	Marks	For markers' use
1	**5**	
2	**5**	
3	**9**	
4	**9**	
5	**5**	
6	**8**	
7	**5**	
8	**7**	
9	**11**	
10	**6**	
11	**6**	
12	**8**	
TOTAL	**84**	

Answer **ALL** questions. Parts marked with "*" involve knowledge of the extension component. Write your answers in the spaces provided.

*1. A student conducts an experiment to verify Boyle's law. The temperature of the gas is kept at 20 °C. Figure 1a shows the p–V graph that the student obtains.

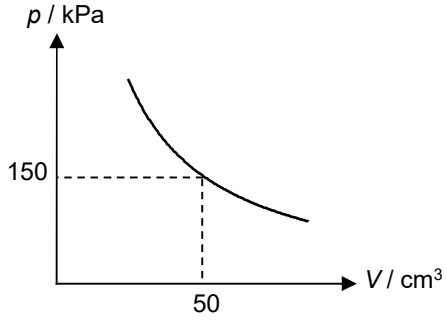


Figure 1a

(a) Find the number of mole of the gas used in the experiment. (2 marks)

(b) The experiment is repeated at 40 °C with the same mass of gas. Find the pressure of the gas when its volume is 50 cm^3. (1 mark)

(c) In Figure 1b, sketch the graphs of p against $\frac{1}{V}$ for $T = 20$ °C and 40 °C.

(2 marks)

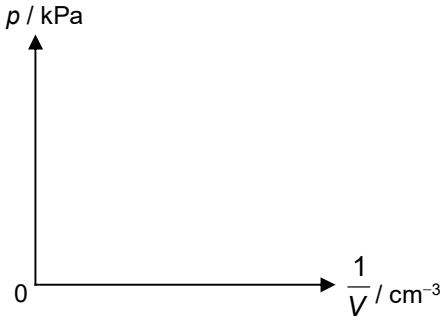


Figure 1b

Answers written in the margins will not be marked.

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2. Some melting ice at 0 °C is added into a glass of hot water of mass 1 kg. Figure 2 shows how the temperature T of the water in the glass changes with time t. It is given that the specific latent heat of fusion of ice is 3.36×10^5 J kg^{-1}.

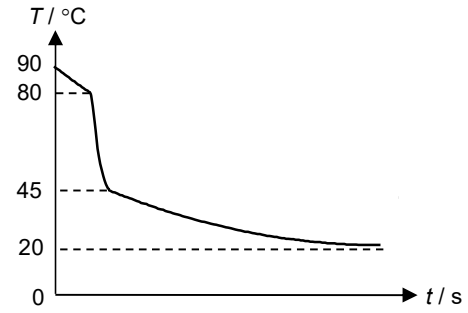

Figure 2

(a) Mark with letter '***P***' in Figure 2 the instant when the melting ice is added into the hot water. (1 mark)

(b) Estimate the room temperature. (1 mark)

(c) Why should the water be stirred throughout the process? (1 mark)

(d) Estimate the mass of the melting ice added into the hot water. Neglect the energy loss to the surroundings during mixing. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

3. Block X, of mass 3 kg, is placed on a rough horizontal table. It is connected to block Y of mass 2 kg by a light inextensible string through a smooth pulley as shown in Figure 3a. Block Y is initially 1.5 m above the ground. At time $t = 0$, the two blocks are released from rest, and block Y reaches the ground after 1 second.

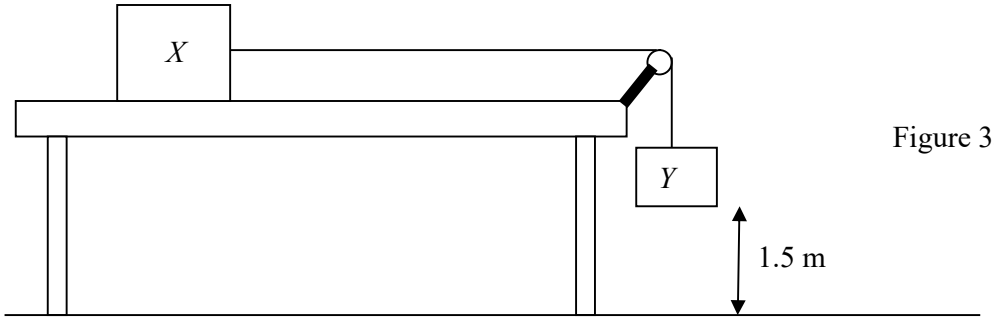

Figure 3a

(a) Show that the acceleration of Y is 3 m s^{-2} when it is falling. (1 mark)

(b) Find the friction acting on block X when block Y is falling. (3 marks)

(c) Describe the subsequent motion of block X after block Y reaches the ground. (1 mark)

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Answers written in the margins will not be marked.

(d) Sketch the velocity-time graph of block X in Figure 3b from $t = 0$ to the time when it comes to a stop. Add significant values on the axes and show your calculation below. (4 marks)

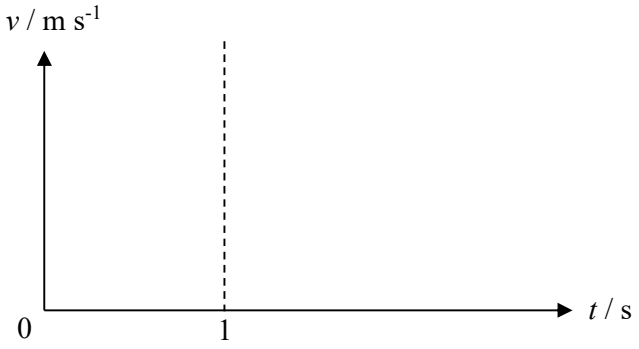

Figure 3b

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4. A uniform ladder AB of length 4 m and mass 10 kg leans against a smooth wall and rests on a rough ground as shown in Figure 4. The angle between the ladder and the ground is 60°. A man of weight 500 N stands on the ladder at C which is 0.75 m above the ground.

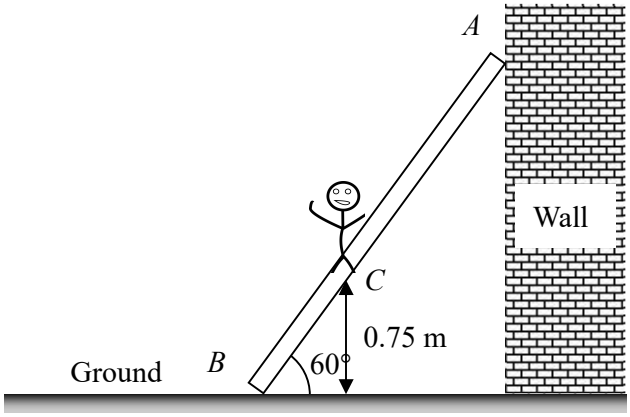
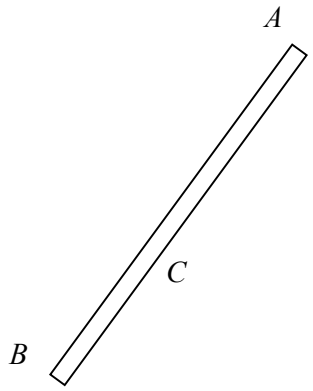


Figure 4

(a) In the figure below, draw a free body diagram to show all forces acting on ladder AB. Label the forces carefully. (2 marks)



(b) Find the force acting on the ladder by the wall. (3 marks)

(c) As the man climbs up the ladder, how do the following quantities change? Briefly explain your answer.

(i) Force acting on the ladder by the wall. (2 marks)

(ii) Vertical force acting on the ladder by the ground. (2 marks)

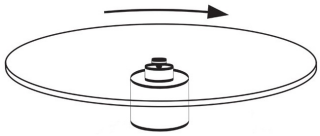
Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

*5. You are provided with a small metal cube of known mass, a plastic ruler and an electronic turntable (the number of revolution per second (n) can be adjusted and is known). Describe an experiment to find the friction between the metal cube and the surface of the turntable. (5 marks)

small metal cube of known mass

plastic ruler



electronic turntable

Answers written in the margins will not be marked.

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6. An object *MN* is placed in front of lens *L*. The following ray diagram shows how a light ray from the object is refracted by *L*.

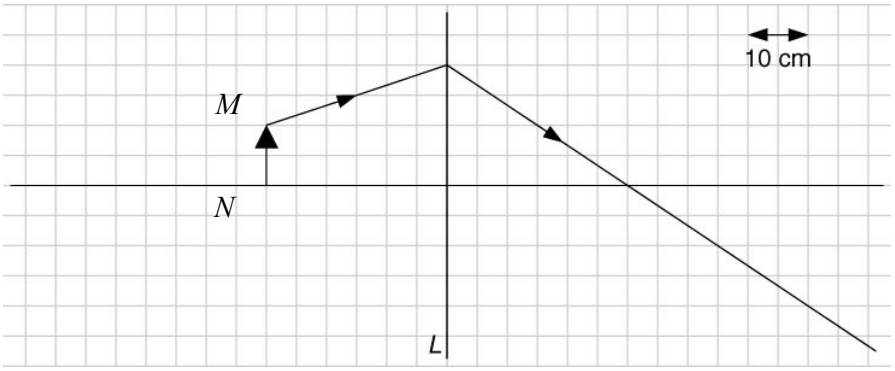

Figure 6

(a) Is lens *L* a convex or a concave lens? Briefly explain your answer. (2 marks)

(b) By adding suitable light rays in figure 6, find the image of *MN*. Label the image ***M'N'***. (2 marks)

(c) What is the focal length of lens *L*? (1 mark)

*(d) If *MN* is placed 80 cm from *L*, find the linear magnification of the image. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

7. The wavelength of some water wave reduces from 3 m to 2 m when the wave travels from region *A* to region *B* as shown in figure 7a.

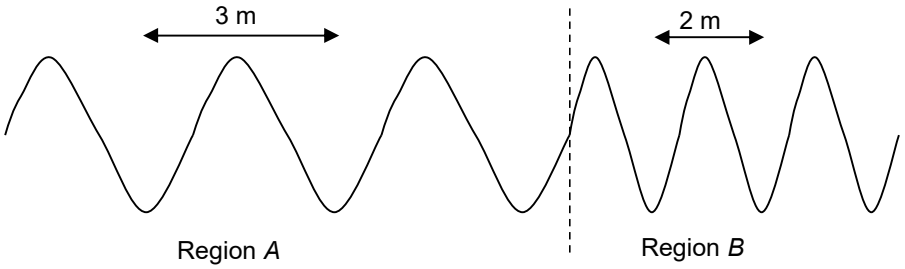

Figure 7a

(a) Name this wave phenomenon. (1 mark)

(b) Which region, *A* or *B*, is the deeper region? (1 mark)

(c) The water waves now travels from region *A* to region *B* in a direction 50° to the boundary as shown in Figure 7b.

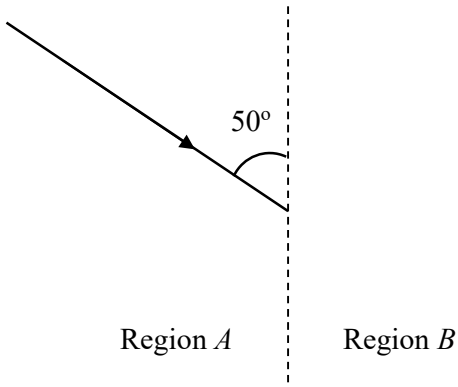

Figure 7b

Find the angle of refraction at region *B*. (3 marks)

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Answers written in the margins will not be marked.

8. Figure 8 shows how the wavelength of a monochromatic light can be measured by interference. Alternate bright and dark fringes are seen on screen PQ, which is 2 m away from the double slits S_1 and S_2.

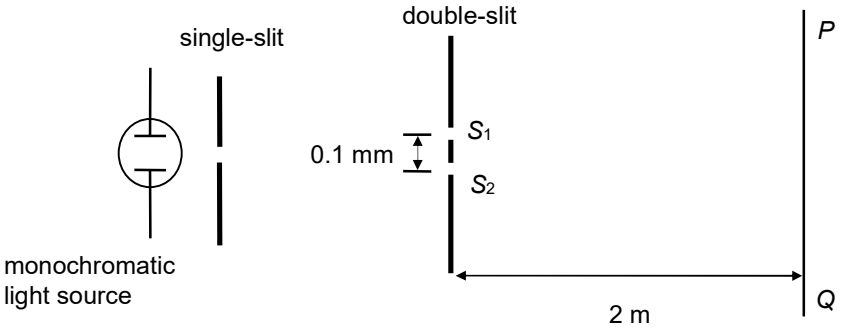

Figure 8

(a) Explain the presence of alternate bright and dark fringes along PQ. (2 marks)

(b) The distance between two consecutive dark fringes is 1.2 cm. Find the wavelength of the monochromatic light used. (2 marks)

(c) If a glass block is placed in front of S_2, explain any change in the position of the zeroth order bridge fringe and the fringe separation. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

9. In figure 9, two long parallel metal plates are separated by 2 cm and the voltage across them is 220 V. At time $t = 0$, a small neutral object is released from rest midway between the plates and it explodes into two small fragments X and Y at the same time. Under the influences of the electric field and gravity, X follows a parabolic path and Y moves rightwards at 2 m s^{-1} along a horizontal path. After a while, X hits the lower plate. The masses of X and Y are 5 g and 8 g respectively. Neglect the electrostatic forces between X and Y.

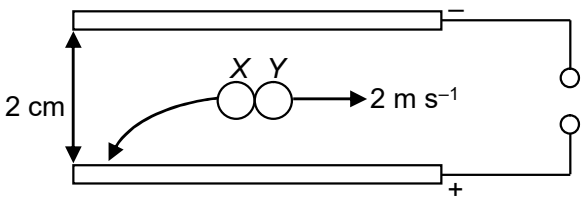

Figure 9

(a) Find the electric field strength between the parallel plates. (2 marks)

(b) State the sign of the charge carried by Y. Calculate the magnitude of charge carried by Y. (3 marks)

Answers written in the margins will not be marked.
Answers written in the margins will not be marked.

(c) Find the speed of X just after the explosion. (2 marks)

(d) Consider the motion of X after the explosion and before it hits the lower plate.

(i) Find the acceleration of X. (2 marks)

(ii) When does X hit the lower plate? (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

10. Read the following description about nominal capacity of a battery and answer the questions that follow.

Information such as e.m.f. and nominal capacity can usually be found on labels of rechargeable cells and batteries.

Figure 10

The nominal capacity of a cell or battery is the total amount of charge which flows through it when it goes from fully charged to fully discharged at the rated voltage. It is usually measured in milliampere-hours (mA h). As shown in figure 10, a battery rated at 2000 mA h can maintain a current of 200 mA for 10 hours or a current of 500 mA for 4 hours. If both the nominal capacity and the operating current of a device are known, we can estimate how long the battery can power a device before it needs to be recharged.

A mobile phone battery has a rated voltage of 3.8 V. Its nominal capacity is 1800 mA h.

(a) Find, in coulombs, the total amount of charge that flow through the battery if it is fully discharged at the rated voltage. (2 marks)

(b) Find the maximum amount of energy stored in the battery. (2 marks)

(c) The manufacturer claims that the mobile phone can play music for 50 hours if fully charged. Estimate the current flowing through the phone when it is playing music. (2 marks)

Answers written in the margins will not be marked.
Answers written in the margins will not be marked.

11. In Figure 11a, a copper rod *XY* of mass 35 g placed on a pair of smooth parallel metal rails making an angle of 30° to the horizontal plane. The rod is perpendicular to the rails, which are 20 cm apart. An upward magnetic field of magnitude 100 mT is applied on the set-up. A voltage is applied across the rails so that a current flows through the copper rod and the rod remains stationary on the rails.

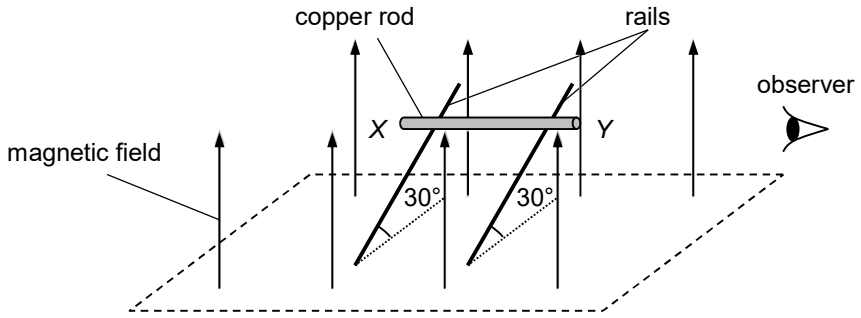

Figure 11a

(a) Mark in Figure 11a the direction of current in the rod. (1 mark)

(b) In Figure 11b, draw all the forces acting on the rod as seen from the observer. Label the forces carefully. (2 marks)

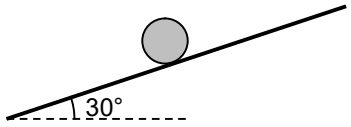

Figure 11b

(c) Find the magnitude of the current in the rod. (3 marks)

Answers written in the margins will not be marked.

12. Radioactive iodine-131 (I-131) is used to cure thyroid cancer. After a patient takes in I-131, it concentrates in the thyroid gland and emits radiation that can destroy the cancer cells. An I-131 nucleus has 53 protons. It emits a β particle to form a xenon (Xe) nucleus which becomes stable after emitting γ radiation.

(a) The half-life of I-131 is 8.02 days. Find its decay constant. (1 mark)

(b) Write down the nuclear equation in the β-decay process of I-131. (2 marks)

(c) Radiation detectors are installed in some airports in order to identify nuclear terrorism. The detectors are extremely sensitive and can detect activity as low as 37 kBq. The airport alarms can be triggered by a patient who has received I-131 therapy up to 95 days ago.

(i) Explain why the detectors can detect the radiation emitted by the source inside the patient's body. (1 mark)

(ii) Estimate the activity of the I-131 inside the patient's body just after the therapy. State your assumption in the calculation. (3 marks)

(iii) Hence, estimate the number of I-131 nuclei received by the patient during the therapy. (1 mark)

END OF PAPER