2020-S6MK

PHY

PAPER 1A

SACRED HEART CANOSSIAN COLLEGE

19 – 20 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 student calibrates a liquid-in-glass thermometer in a physics lesson. At room temperature 25 °C, the liquid column in the thermometer is 6.4 cm. When he puts the thermometer in boiling water, the liquid column becomes 14.9 cm. Assume the liquid expands or contracts linearly with the temperature change. How long is the liquid column when the temperature is 50 °C?

   A. 2.83 cm
   B. 9.23 cm
   C. 10.5 cm
   D. 12.8 cm

2. On a hot sunny day, the wind blows from the sea to the land. Which of the following is a possible reason?

   A. The sea is hotter than the land.
   B. The land is hotter than the sea.
   C. The sea is a better conductor of heat than the land.
   D. The land is a better conductor of heat than the sea.

3. Peter puts 500 g of ice cubes at −5 °C in a cup of 500 g water at 80 °C as shown. Assume there is no heat loss to the surroundings, what is the final temperature of this mixture?

   Given: specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$
   specific heat capacity of ice = 2100 J kg^{-1} $°C^{-1}$
   specific latent heat of fusion of ice = 3.34×10^5 J kg^{-1}

   A. 0 °C
   B. 4.51 °C
   C. 10.2 °C
   D. 17.7 °C

*4. In which of the following situations would the r.m.s. speed of the molecules of a fixed mass of an ideal gas increase?

(1) The gas is heated at constant pressure.

(2) The gas expands under constant temperature.

(3) The gas pressure increases under constant volume.

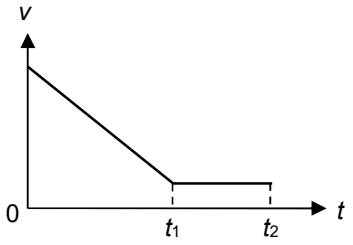
A. (1) only

B. (2) only

C. (1) and (3) only

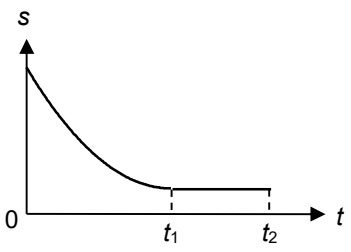
D. (1), (2) and (3)

5. An object moves along a straight pathway according to the velocity-time graph below.

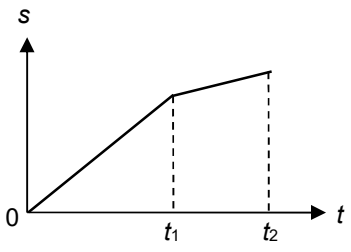


Which of the following graphs best shows the variation of the displacement s of the object with time t?

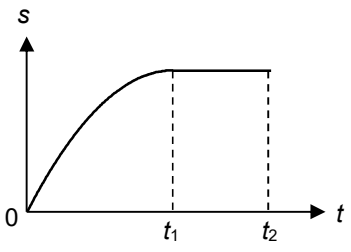
A.



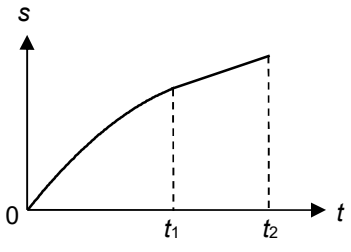
B.



C.



D.

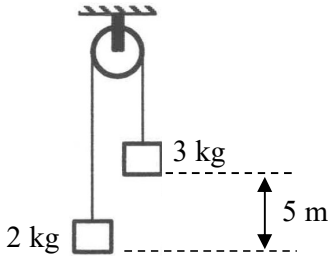


*6. A cannon ball is fired at an angle 25° above the horizontal with initial kinetic energy K. What is the kinetic energy of the cannon ball at the highest position?

A. 0.906 K
B. 0.821 K
C. 0.423 K
D. zero

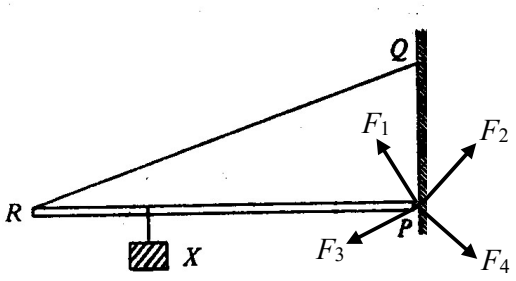
7. Two blocks of respective masses 2 kg and 3 kg are connected by a light inextensible string which passes over a smooth fixed light pulley as shown. The system is released from rest. Estimate the speed of the 3-kg block when both blocks are at the same level of height.

A. 1.12 m s^{-1}
B. 2.53 m s^{-1}
C. 2.97 m s^{-1}
D. 3.13 m s^{-1}

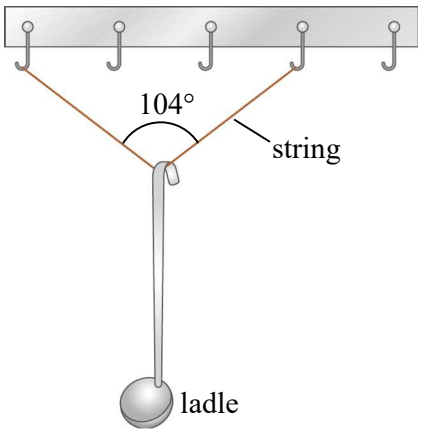


8. A uniform light rigid rod is hinged smoothly to a wall at P and the other end R is connected by a wire attached to the wall at Q, vertically above P. A weight X is hung somewhere on the rod as shown. If the rod remains horizontal, which force most probably represents the reaction force acting on the rod due to the wall?

A. F_1
B. F_2
C. F_3
D. F_4

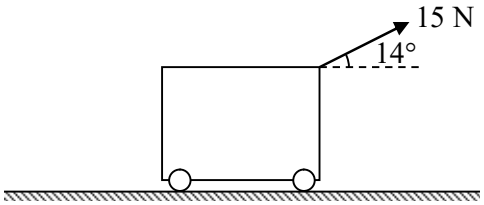


9. In the figure, the two ends of an inextensible string are fixed on two hooks. A ladle is hung on the string so that the string makes an angle of 104°. If the weight of the ladle is 10 N, find the tension in the string.



A. 5 N
B. 6.35 N
C. 8.12 N
D. 10 N

10. A suitcase of 6 kg is placed on a rough horizontal ground as shown below. John pulls the suitcase with a force of 15 N at 14° to the horizontal and the suitcase accelerates forwards at 0.5 m s^{-2}. Find the frictional force acting on the suitcase by the ground.

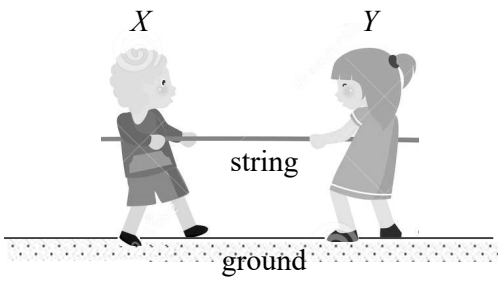


A. 1.42 N
B. 5.06 N
C. 8.41 N
D. 11.6 N

*11. A satellite of mass m revolves around the Earth in a circular orbit of radius R. The orbital speed of the satellite is v. If the satellite revolves around the Earth at speed $2v$, what is the radius of the circular orbit?

A. $\frac{R}{\sqrt{2}}$
B. $\frac{R}{2}$
C. $\frac{R}{2\sqrt{2}}$
D. $\frac{R}{4}$

12.



X and Y are playing tug as war as shown above. Which of the following is/are action-reaction pair(s)?

(1) the tension acting on X and the tension acting on Y

(2) the weight of X and the normal force on X by the ground

(3) the friction on X by the ground and the horizontal force acting on the ground by X

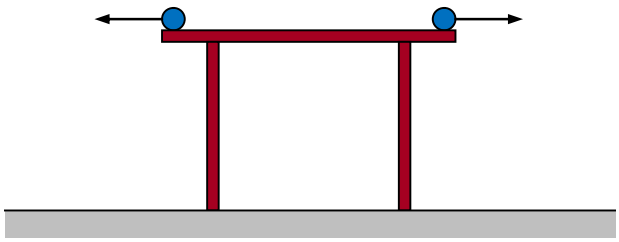
A. (3) only

B. (1) and (2) only

C. (1) and (3) only

D. (2) and (3) only

*13. Two balls of different masses are projected horizontally from a table surface at the same time as shown below. The initial speeds of the two balls are different.



If the air resistance is negligible, which of the following statements is/are correct?

(1) The two balls will reach the ground at the same time.

(2) The two balls will reach the ground at the same speed.

(3) The two balls will reach the ground at the same angle to the ground.

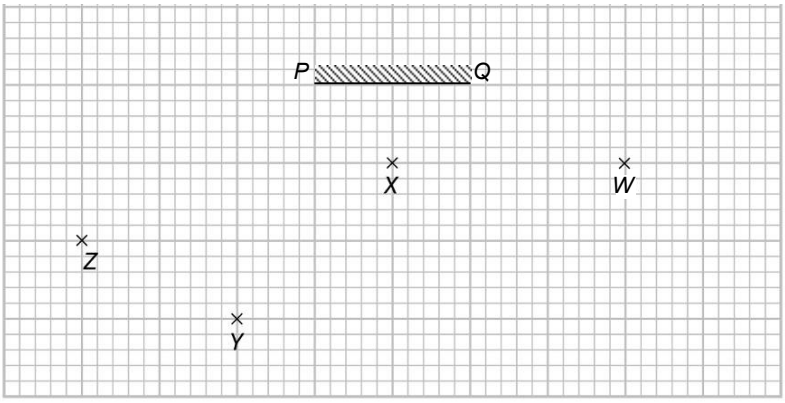
A. (1) only

B. (1) and (2) only

C. (1) and (3) only

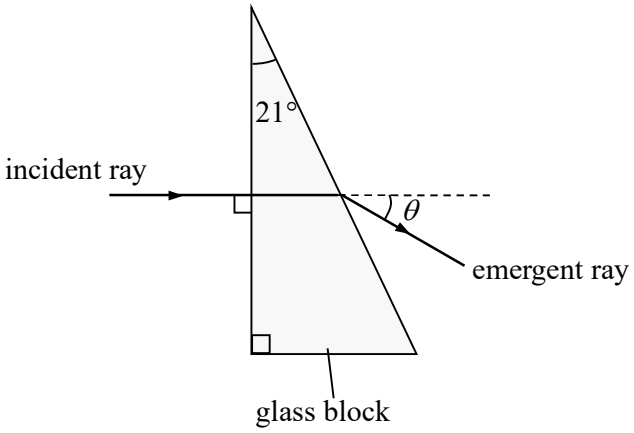
D. (2) and (3) only

14. A girl stands at X in front of a mirror PQ as shown. Whom will she see in the mirror?



A. W only
B. Y only
C. Y and Z only
D. W, Y and Z

15. A light ray passes through a triangular glass block as shown below.



If the refractive index of the glass is 1.5, find the value of θ.

A. 11.5°
B. 17.8°
C. 19.5°
D. There is no emergent ray as total internal reflection occurs.

16. Which of the following phenomena is **NOT** related to refraction of light?

A. A swimming pool looks shallower than it actually is.
B. A pencil appears to be bent when immersed in a beaker of water.
C. The phase of the Moon changes periodically in every month.
D. The objects you see through the hot air appears blurred and flickering.

17. Which of the following about the virtual image formed by a lens are correct?

(1) The virtual image is always diminished.
(2) The virtual image is always erect.
(3) The virtual image is always on the same side of the object.

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

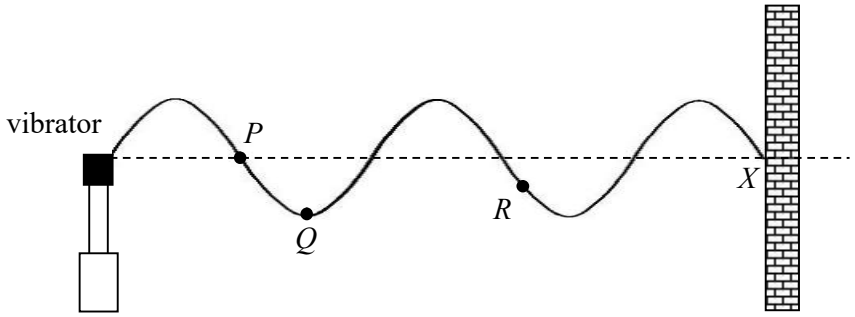
18. A light beam that consists of a blue light and an orange light incident normally on a diffraction grating. It is found that the 4^{th} order blue fringe overlaps with the 3^{rd} order orange fringe on the screen. If a grating with more lines per mm is used, which of the following about the fringes' positions is correct?

A. The 4^{th} order blue fringe displaces more than the 3^{rd} order orange fringe.
B. The 3^{rd} order orange fringe displaces more than the 4^{th} order blue fringe.
C. The two fringes still overlap, and they move towards the 0^{th} order bright fringe.
D. The two fringes still overlap, and they move away from the 0^{th} order bright fringe.

19. Which of the following about sound is **NOT** correct?

A. Sound is produced by vibration.
B. Sound is a longitudinal wave.
C. The speed of sound is higher in air than in water.
D. Sound cannot travel in vacuum.

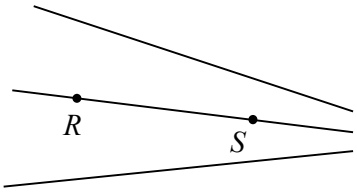
20. A string is fixed one end to the wall at X and the other end to a vibrator. A stationary wave is produced on the string. The following figure shows the shape of the string at a certain instant. The dotted line shows the shape of the string when it is at rest. Which of the following statements **MUST** be correct?



(1) Particle P remain at rest for all time.
(2) Particle Q is at its maximum displacement.
(3) Particle Q and R vibrate in phase.

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

21. The figure below shows some electric field lines without the directions. A charged particle released from rest at S is found to move towards R along the field line. Which of the following statements **MUST** be correct?

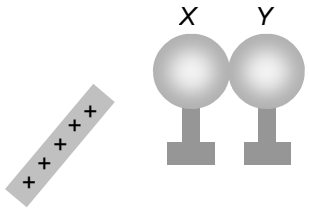


(1) The particle is positively charged.
(2) The particle decelerates as it approaches R.
(3) Work is done by the electric force on the charge.

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

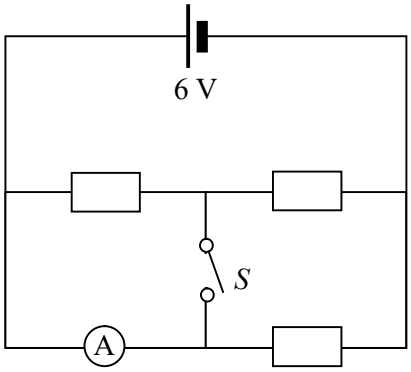
22. Two insulated uncharged metal spheres X and Y are placed in contact with each other. An insulated positively charged rod is put near X. Y is earthed momentarily and then the positively charged rod is removed. X and Y are then separated. What are the net charges on X and Y respectively?

	X	***Y***
A.	negative	negative
B.	negative	positive
C.	positive	zero
D.	positive	negative



23. A 6-V cell, an ideal ammeter, three identical resistors and a switch S are connected as shown in the figure below. When the switch is open, the ammeter reads 3 A. Find the ammeter reading when the switch is closed.

A. 1 A
B. 2 A
C. 3 A
D. 6 A

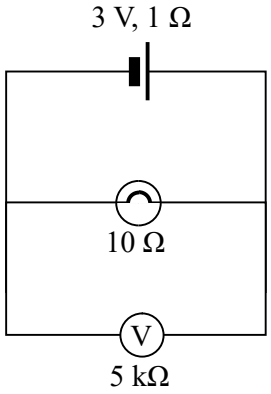


*24. An incandescent lamp works at power P when it is connected to a sinusoidal a.c. power supply of peak voltage V_0. If the peak voltage is changed to $2V_0$, what are the r.m.s. value of the voltage and the power output? Assume the resistance of the lamp remains unchanged.

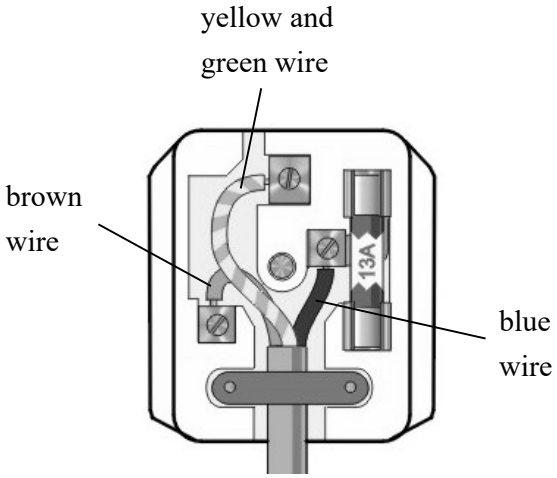
	r.m.s. value of the voltage	**power output**
A.	$\sqrt{2}\,V_0$	$2\,P$
B.	$\sqrt{2}\,V_0$	$4\,P$
C.	$2\sqrt{2}\,V_0$	$2\,P$
D.	$2\sqrt{2}\,V_0$	$4\,P$

25. A 3-V dry cell of internal resistance 1 Ω, a voltmeter of internal resistance 5 kΩ and a light bulb of resistance 10 Ω are connected as shown in the circuit diagram below. Find the reading of the voltmeter.

A. 3 V
B. 2.99 V
C. 2.73 V
D. 2.53 V

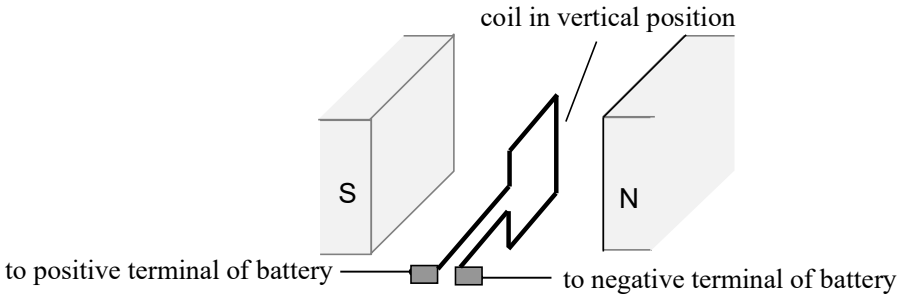


26. The wires in the three-pin plug of an electric kettle with a metal case are wrongly connected as shown in the figure below. What may happen to the user and the fuse if the brown wire inside the kettle accidentally touches the metal case?



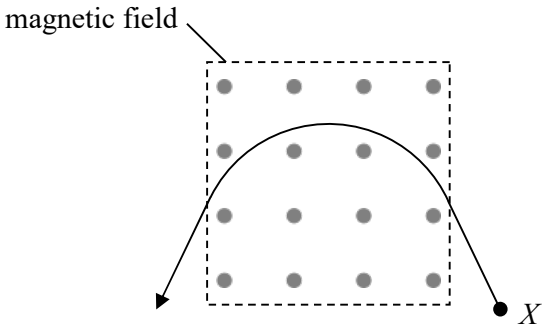
	user	**fuse**
A.	does not get an electric shock	does not melt
B.	does not get an electric shock	melt
C.	get an electric shock	does not melt
D.	get an electric shock	melt

27. A coil connected to a battery lies along the vertical plane between two slab magnets as shown in the figure below. What is the subsequent motion of the coil if it is released from rest?



A. It remains at rest.
B. It oscillates about the vertical plane.
C. It rotates in clockwise direction.
D. It rotates in anticlockwise direction.

28. When a charged particle *X* enters a region of uniform magnetic field pointing out of paper, it travels along the path as shown below.

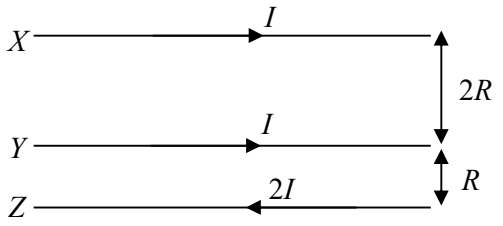


Assume the effect of gravity is negligible, which of the following statements are correct?

(1) *X* is negatively charged.
(2) The trajectory of *X* in the magnetic field is a projectile motion.
(3) The speed of *X* remains the same in the magnetic field.

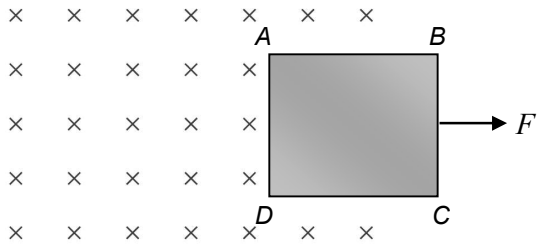
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

29. Three long parallel wires X, Y and Z carry currents I, I and $2I$ respectively. X and Y are $2R$ apart while Y and Z are R apart as shown below. The magnitude of the net force acting on Y is F. Find the magnitude of the net force acting on Y if X and Z interchange their positions.



A. 0.6 F
B. 0.8 F
C. 1.2 F
D. 1.4 F

30.



In the figure above, a metal plate $ABCD$ is placed normally to a uniform magnetic field which is pointing into the paper. The plate is being pulled by a horizontal force F. When the plate is leaving the magnetic field from the right side, which of the following are correct?

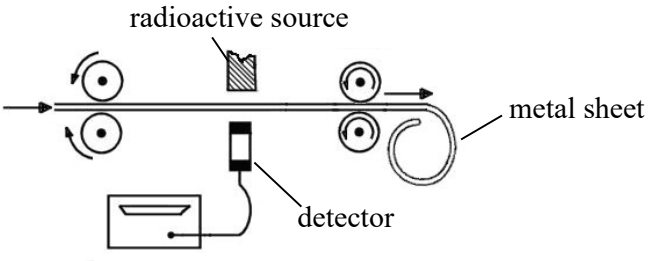
(1) The eddy current in the plate flows in clockwise direction.
(2) The plate heats up.
(3) There is another force acting on the plate and it is opposite to F.

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

31. How many α decays and β decays have radioactive nuclide ${}^{232}_{90}P$ undergone to form nuclide ${}^{228}_{90}Q$?

A. 1 α decay, 2 β decays
B. 2 α decays, 1 β decay
C. 1 α decay only
D. 2 α decays, 4 β decays

32. A radioactive source and a detector are used in a factory to monitor the thickness of the metal sheet manufactured. Which of the following radioactive sources is the most appropriate to use?



radioactive source	half-life	type of radiation emitted
P	5 days	α radiation
Q	5 days	β radiation
R	10 years	α radiation
S	10 years	β radiation

A. *P*
B. *Q*
C. *R*
D. *S*

33. Consider the following nuclear reaction:

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$$

Which of the following statements is/are correct?

(1) The neutron produced would cause the nuclear reaction to become a chain reaction.
(2) The total mass of $^{4}_{2}He$ and $^{1}_{0}n$ is less than that of $^{2}_{1}H$ and $^{3}_{1}H$.
(3) The reaction is a nuclear fusion.

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

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

2020-S6MK

PHY

PAPER 1B

B

SACRED HEART CANOSSIAN COLLEGE

19 – 20 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.
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	**10**	
2	**8**	
3	**9**	
4	**8**	
5	**8**	
6	**9**	
7	**7**	
8	**8**	
9	**11**	
10	**6**	
TOTAL	**84**	

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

1. A cat of mass 0.8 kg is initially at rest on the top of a cupboard as shown. The cat suddenly falls vertically towards the ground which is 1.5 m below. Assume that air resistance is negligible.

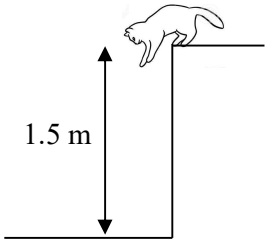


Figure A

(a) Find the vertical speed of the cat just before it hits the ground. (2 marks)

(b) Find the time of fall of the cat in the air. (2 marks)

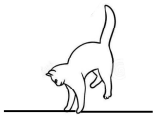
Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(c) When the cat lands on the ground, it is stopped by the ground in 0.2 s.

(i) In the figure below, draw a free-body diagram of the cat when it lands on the ground. Label all force(s) in the figure. (2 marks)

Figure B



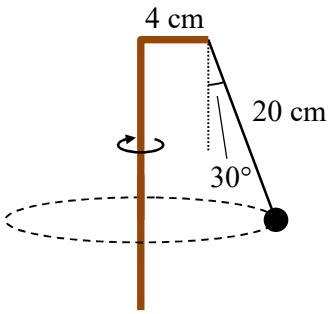
(ii) Find the direction and the magnitude of the average force acting on the cat by the ground during the landing. (3 marks)

(iii) Suggest what the cat should do during landing to avoid injury. (1 mark)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

*2. A ball is attached to an L-shaped wooden frame with a light inelastic string as shown below. The frame is rotating at a constant angular speed ω = 4 rad s^{-1} and the ball undergoes uniform circular motion. The horizontal branch of the frame is 4 cm long. The string is 20 cm long and makes an angle of 30° to the vertical during rotation.



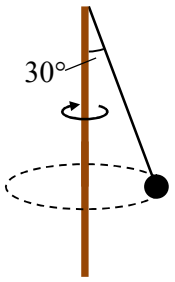
(a) Find the period of time (in second) of one revolution. (1 mark)

(b) If the ball is 0.24 kg, find the centripetal force of the ball. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(c) The horizontal part of the wooden frame is now removed and the ball undergoes uniform circular motion as shown below. Assume the angular speed of the ball remains unchanged.



(i) Explain whether the magnitude of the centripetal force of the ball is greater than, equal to or smaller than the value found in (b). (2 marks)

(ii) If the string is suddenly broken, describe the succeeding motion of the ball. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

3. A boy observes an object '**P**' through a lens as shown in Figure 3A. He finds that the image is inverted when the object is placed at certain position.

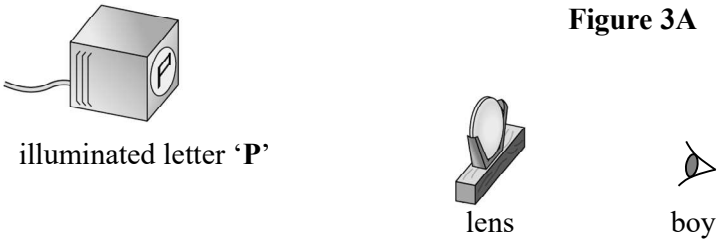


Figure 3A

(a) Which type of lens is used? (1 mark)

(b) In Figure 3B, *AB* represents the image formed by the lens. If the magnification of the image is 0.5, locate the object on the figure. (2 marks)

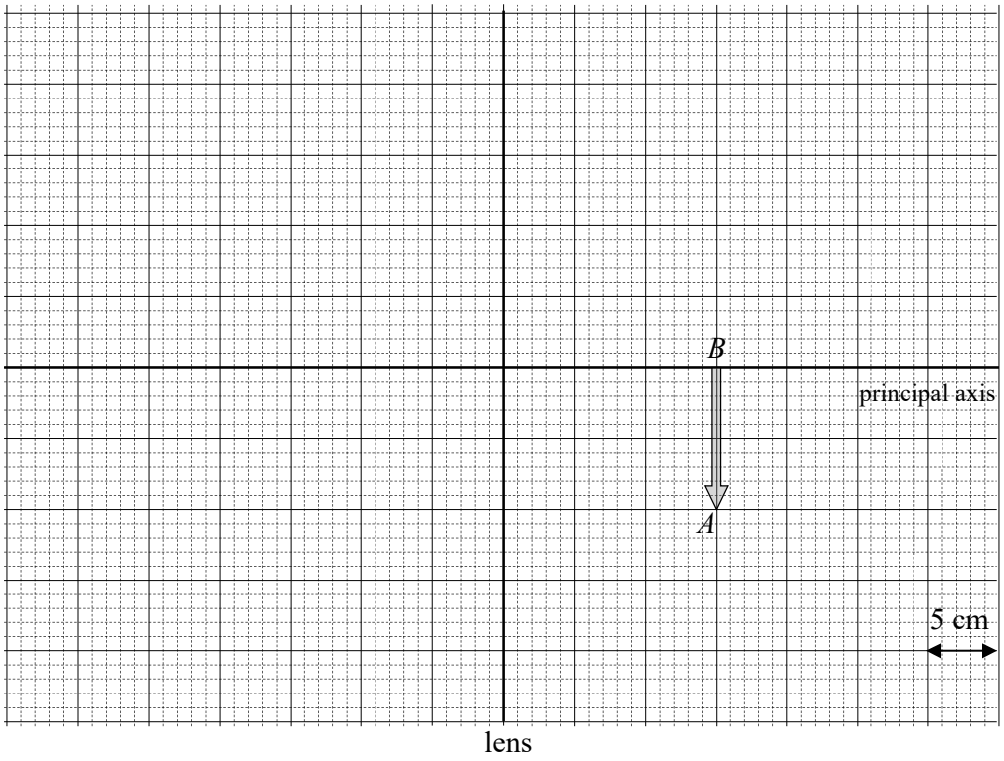


Figure 3B

Answers written in the margins will not be marked.

(c) Draw a suitable light ray on the figure to locate and mark the position of the focus of the lens with '*F*'. What is the focal length of the lens? (3 marks)

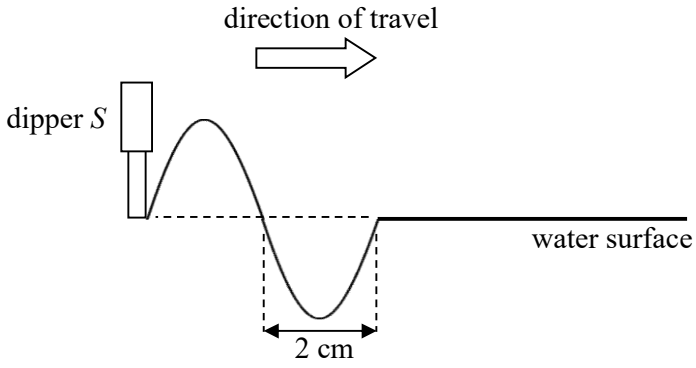
focal length = ...

*(d) If the boy places the object 60 cm from the lens, find the magnification of the image. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

4. A dipper S vibrates vertically on a ripple tank to produce a train of water wave. The period of the vibration is 0.5 s. The figure below shows the water wave at time $t = 0$.



(a) Find the speed of the wave. (2 marks)

(b) Sketch the waveform at time $t = 1.5$ s in the figure below. (2 marks)

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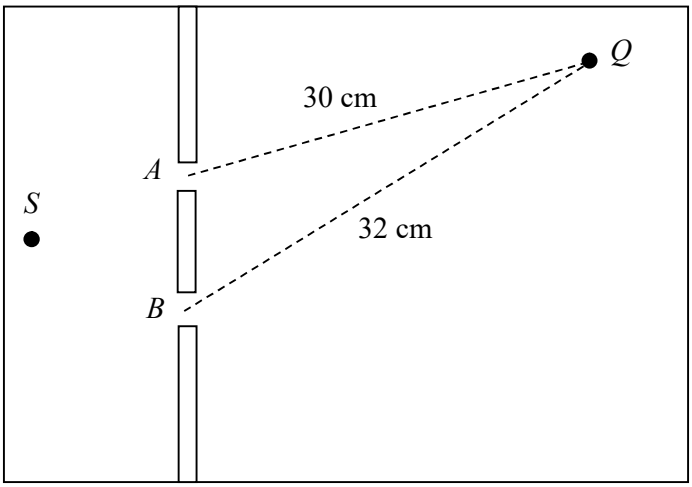
(c) A double slit barrier is added in the ripple tank as shown in the figure below. Q is a point 30 cm away from slit A and 32 cm away from slit B.



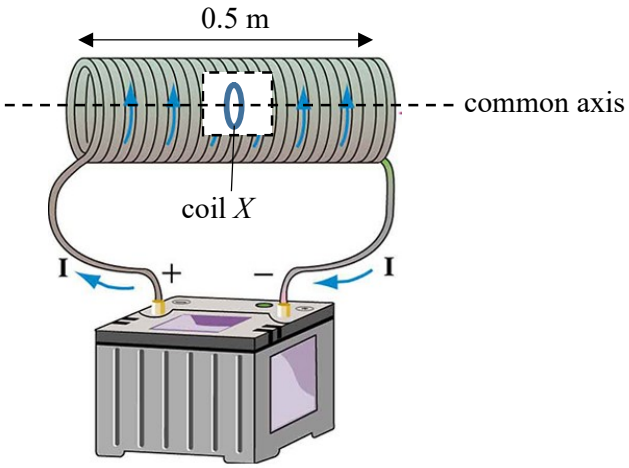
(i) Show that the water at Q always remains calm. (2 marks)

(ii) Explain why the water at Q is no longer calm if the frequency of the dipper is doubled. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

*5. A 10-turn small circular coil X of area 2×10^{-4} m^2 is placed in the middle of a solenoid as shown below. The length of the solenoid is 0.5 m, and it contains 100 turns and carries a current I .



(a) Given that current I is fixed at 1.5 A.

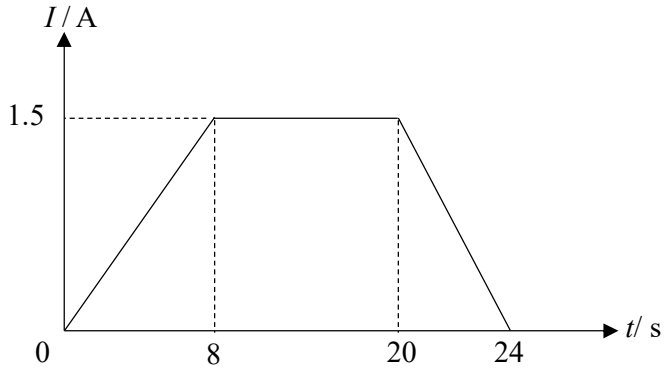
(i) Estimate the magnetic field strength in the middle of the solenoid.

(2 marks)

(ii) Assume that the magnetic field passes normally through coil X. Show that the magnetic flux linkage of coil X is 7.54×10^{-7} Wb. (1 mark)

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

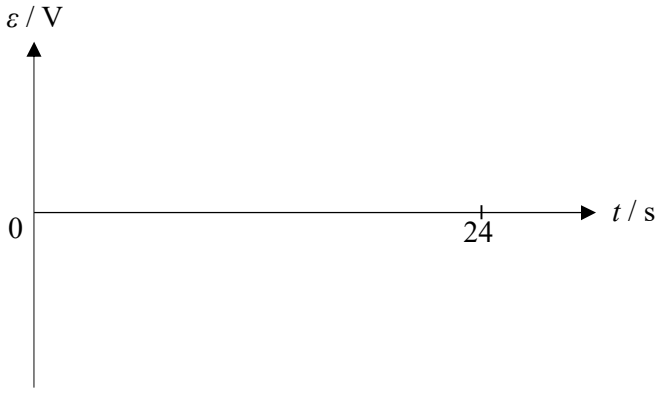
(b) By adjusting the voltage in the power supply, the current I in the solenoid varies with time t as shown in the graph below.



(i) Find the induced e.m.f. ε in coil X in the first 8 s. (2 marks)

(ii) In the figure below, sketch how the induced e.m.f. ε varies with time t from 0 to 24 s.

(3 marks)



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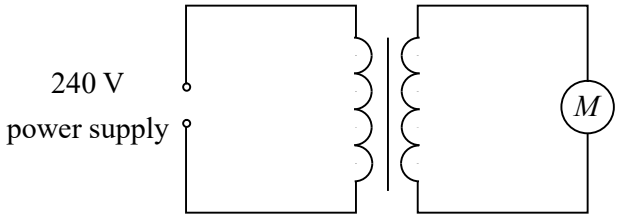
*6. A motor rated '12 V, 96 W' is connected to a 240-V power supply through a transformer of efficiency 80% as shown below. The motor is working at the rated value.

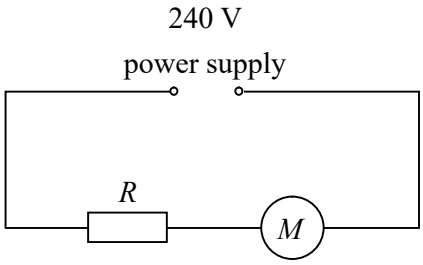


(a) Is the power supply an a.c. source or a d.c. source? (1 mark)

(b) Calculate the turn ratio of the transformer. (1 mark)

(c) Find the current in the primary circuit. (2 marks)

(d)



The circuit diagram above shows another way to operate the motor. With a resistor of certain resistance R connected to the motor in series, the motor can work at the rated value. Find the value of R. (3 marks)

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

(e) State **ONE** advantage and **ONE** disadvantage of using the circuit in (d) comparing to the circuit using a transformer. (2 marks)

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Answers written in the margins will not be marked.

7. Carbon-14 dating is a method to determine the age of dead plants. It is known that radioisotope carbon-14 $\left({}^{14}_{6}C\right)$ decays spontaneously to form nitrogen-14 $\left({}^{14}_{7}N\right)$. The half-life of such decay is approximately 5 700 years.

(a) Which type of radioactive decay takes place when carbon-14 decays to form nitrogen-14? (1 mark)

(b) It is known that there is only one carbon-14 atom for every 10^{12} carbon atoms in nature. In a fresh wood sample, the activity due to carbon-14 is found to be 5.80 Bq. Given that 1 year = 3.156×10^{7} s.

(i) Find the decay constant of carbon-14. Express the answer in s^{-1}. (1 mark)

(ii) Hence, estimate the number of carbon atoms in the sample. (2 marks)

*(c) Consider a dead plant sample X having the same carbon content as the fresh sample in (b). If the activity due to the carbon-14 in X is found to be 1.02 Bq, estimate the age of X. (2 marks)

Answers written in the margins will not be marked.

(d) The accuracy of carbon-14 dating would be very low if the age of the dead plant sample is too far from now. Explain why it is so. (1 mark)

.....

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Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

8. The following nuclear reaction occurs in a nuclear power station.

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{96}_{40}Zr + ^{135}_{52}Te + 5\,^{1}_{0}n$$

Given: mass of $^{235}_{92}U$ = 235.043 923 u
mass of $^{96}_{40}Zr$ = 95.908 273 u
mass of $^{135}_{52}Te$ = 134.916 449 u
mass of $^{1}_{0}n$ =1.008 665 u

*(a) Find the energy released in the above reaction in MeV. (2 marks)

*(b) A nuclear power station has power output of 600 MW. If the efficiency of the reactor is 35%, estimate the number of the above reaction occurred in one second. (2 marks)

(c) The daughter nuclei, i.e. *Zr* and *Te*, of the reaction are radioactive. To dispose these nuclear wastes safely, they are sealed in a steel container and stored for years. What types of radiation do $^{96}_{40}Zr$ and $^{135}_{52}Te$ probably emit? Explain your answer. (2 marks)

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

(d) A student claims that instead of a slow-moving neutron, the bombardment of slow-moving electrons with uranium-235 atoms may also trigger this nuclear reaction. Do you agree? Explain your answer. (2 marks)

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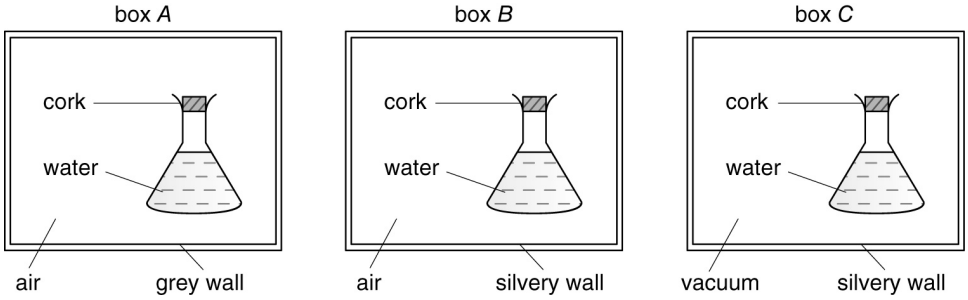
9. (a) Three identical conical flasks containing the same amount of hot water are put into different plastic boxes for some time.



(i) When the inner side of the flask is heated by hot water, the outer side of the flask gradually becomes hot. Explain this phenomenon in terms of particle motion. (3 marks)

(ii) Which setup is the best for heat insulation? Explain in terms of processes of heat transfer. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(b) In another experiment, you are given the following apparatus.


electric hotplate


beaker of 0.5 kg water


thermometer


stopwatch

Describe how you can estimate the useful output power of the electric hotplate. Write the expression for calculating the power. State **ONE** assumption you should make in the experiment. (5 marks)

Answers written in the margins will not be marked.

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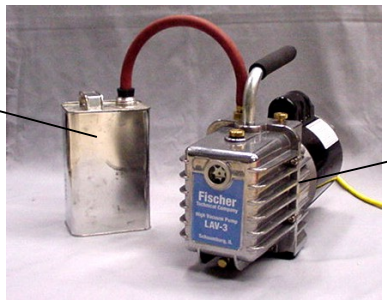
*10. Peter connects an empty can to a vacuum pump with a rubber tube as shown below. The dimension of the can is 0.6 m × 0.1 m × 0.2 m. The initial air pressure in the can is 1 atm. Assume air behaves like an ideal gas. (Take 1 atm = 100 kPa.)



Peter turns on the pump for a while, so that the pressure in the can drops to 0.5 atm and the temperature drops to 18°C.

(a) Find the number of moles of the air particles inside the can. (2 marks)

(b) Find the total kinetic energy of the air inside the can. (2 marks)

(c) Peter seals the can and immerses the whole can in ice water. In terms of kinetic theory, explain why the air pressure in the can would get even lower. (2 marks)

END OF PAPER

Answers written in the margins will not be marked.
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