PO LEUNG KUK TANG YUK TIEN COLLEGE
F.6 MOCK EXAMINATION (19/20)

Form	:	6	Date	:	Feb 03, 2020
Subject	:	Physics	Time	:	08:30 – 11:00
Paper	:	I	Class	:	_____(____)
Full Mark	:	33 (Section A)	Name	:	_____

GENERAL INSTRUCTIONS

1. There are **TWO** sections, A and B, in this paper. You are advised to finish Section A in about 60 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 Question-Answer Book **B**. **The Answer Sheet for Section A and the Question-Answer Book 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 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. Follow also the instructions given in the announcement before the start of the examination. You should write your Name, Class and Class number in the spaces provided on the Answer Sheet. No extra time will be given to candidates for filling in their personal information after the 'Time is up' announcement.

2 When told to open this book, you should check that all the 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.

There are 33 questions.

Section A

1. To prepare cup noodles, 400 g hot water at 95 ℃ is poured into the paper cup that contains 120 g noodles. Assume the room temperature is 25 ℃. Ignore the heat loss to the surroundings. Estimate the final temperature of the mixture.

Given: specific heat capacity of the noodles = 1800 J kg^{-1} $℃^{-1}$
specific heat capacity of water = 4200 J kg^{-1} $℃^{-1}$

A. 66.2 ℃ B. 74.0 ℃
C. 78.8 ℃ D. 87.0 ℃

2. A bottle of hot water left in a bench will cool down gradually to the room temperature.Closing the bottle with a cork can greatly slow down the cooling process. Which of the following best explain the function of corking?

(1) It stops infrared radiation from leaving the bottle.
(2) It prevents hot air in the bottle from mixing with the surrounding cold air.
(3) It slows down the evaporation of hot water.

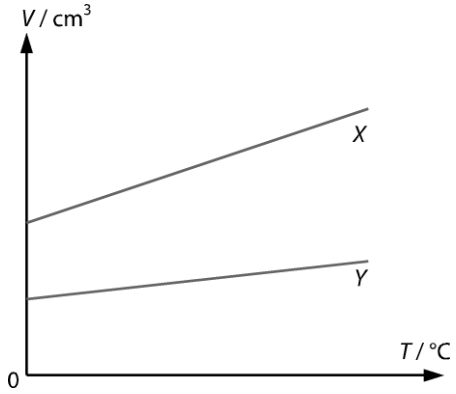
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

3. Some water of 2 kg at 20 ℃ is poured into a beaker of melting ice. The mixture has a temperature of 0 ℃. Which of the following statements is/are correct? The specific heat capacity of water is 4200 J kg^{-1} $℃^{-1}$ and the specific latent heat of fusion of ice is 3.34×10^5 J kg^{-1}. Neglect any energy gained from or lost to the surroundings.

(1) The mass of melting ice **must** be larger than 2 kg.
(2) For the melting ice, the average kinetic energy due to random motion of the molecules remains unchanged.
(3) The total internal energy of the ice and the water remains unchanged.

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

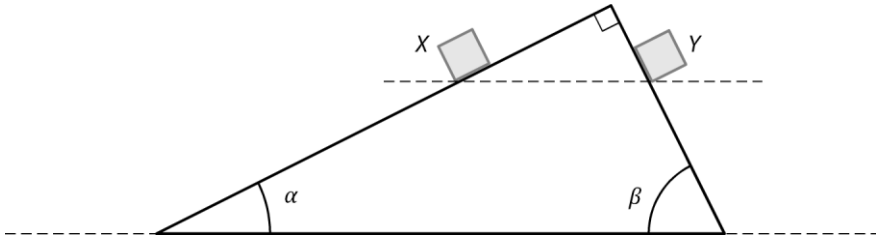
4. Two ideal gases *X* and *Y* are kept at the same pressure. Their volume–temperature (*V*–*T*) graphs are as shown.



Which of the following statements can be deduced from the graph?
(1) The two graphs have the same intercept on the temperature axis.
(2) *X* is more massive than *Y*.
(3) The number of moles of *X* is larger than that of *Y*.

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

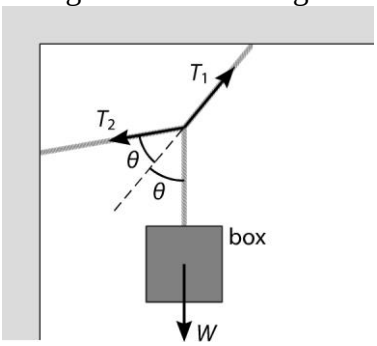
5. A triangular ramp is fixed on a horizontal bench. The ramp has two smooth slopes with inclined angles $\alpha < \beta$ and has a right angle at the top, as shown. Two identical small blocks *X* and *Y* are released from rest, one on each side from the same height and at the same time.



Which of the following statements are correct?
(1) Block *X* slides down with smaller acceleration in magnitude than block *Y*.
(2) The two blocks reach the bench at the same time.
(3) The two blocks reach the bench at the same speed.

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

6. A box of weight W is hung by two strings as shown. It is given that $\theta < 45°$.



Which of the following relations are correct?

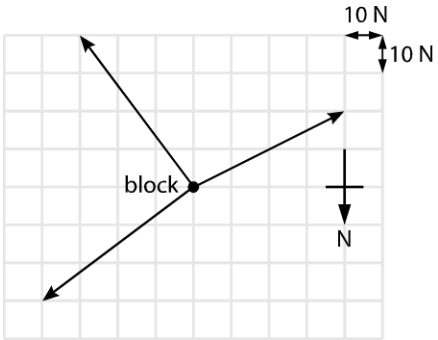
(1) $T_2 < T_1$ (2) $W < T_1 < 2W$ (3) $T_2 < W$

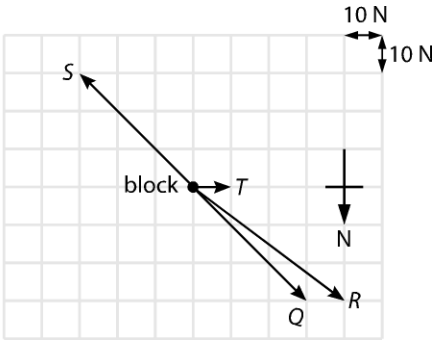
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

7. On the Moon's surface, an astronaut drops a heavy hammer and a feather at the same time. The hammer falls at the same rate as the feather. Which of the following statements best describes the phenomenon?

A. The hammer experiences the same acceleration as the feather.
B. The hammer experiences the same net force as the feather.
C. The hammer experiences a smaller gravitational force than the feather.
D. The hammer experiences a larger air resistance than the feather.

8. Four forces act on a block of mass 5 kg and three of them are shown below. As a result, the block accelerates at 2 m s^{-2} due west.

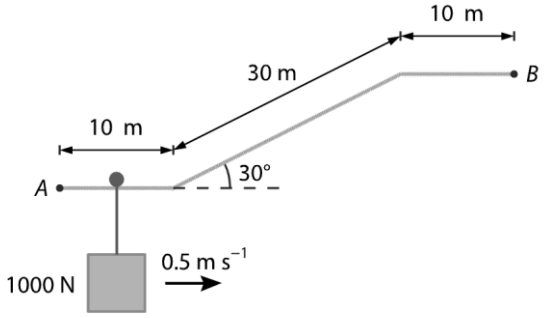




What is the remaining force?

A. S
B. T
C. R
D. Q

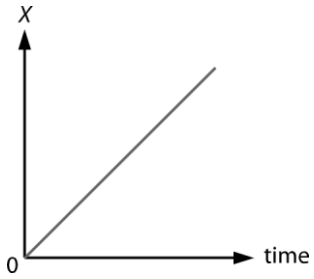
9. A load of weight 1000 N is transferred from *A* to *B* by a ropeway as shown. The load moves at a constant speed of 0.5 m s^{-1}.



Find the work done on the load when it is transferred from *A* to *B*.

A. 15 000 J
B. 25 000 J
C. 50 000 J
D. 147 000 J

10. A trolley is released from rest on a smooth inclined runway. An unknown quantity *X* varies linearly with time as shown.



X may represent

A. the horizontal displacement of the trolley.
B. the horizontal component of the velocity of the trolley.
C. the gain of kinetic energy of the trolley.
D. the gain of potential energy of the trolley.

11. Two identical balls *P* and *Q* are placed on a smooth track as shown. The track consists of a curved segment *AB* of height *h* and a horizontal segment *BC*. Initially, *P* and *Q* are held at rest at *A* and *B* respectively.

When *P* is released, it moves down the track and collides with *Q*. The two balls move together towards *C* at a common speed after collision. Which of the following statements is/are INCORRECT?

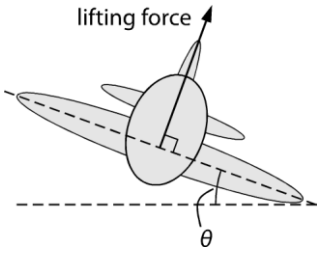
(1) The total momentum of the balls conserves during the collision.
(2) The total kinetic energy of the balls conserves during the collision.
(3) The common speed of the two balls is $\sqrt{gh}$.

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

12. A cannon of mass 250 kg is placed at rest on level ground. It fires a cannonball of mass 4 kg at an angle of 15° above the horizontal. The cannonball leaves the barrel with a speed *v*. The cannon recoils at a speed of 2 m s^{-1} just after it fires. Find the value of *v*. Neglect friction.

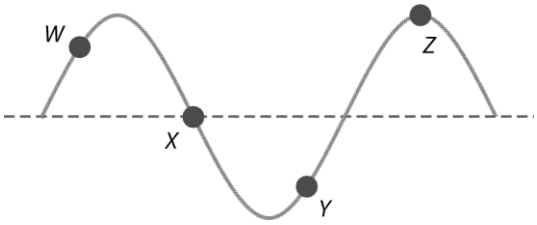
A. 125 m s^{-1} B. 129 m s^{-1}
C. 133 m s^{-1} D. 137 m s^{-1}

13. A plane at speed 900 km h^{-1} flies along a horizontal circular path of radius 10 km. The lifting force of the plane is normal to the wings as shown. What is the value of angle θ between the wings and the horizontal?



A. 0.526°
B. 2.81°
C. 32.5°
D. 83.1°

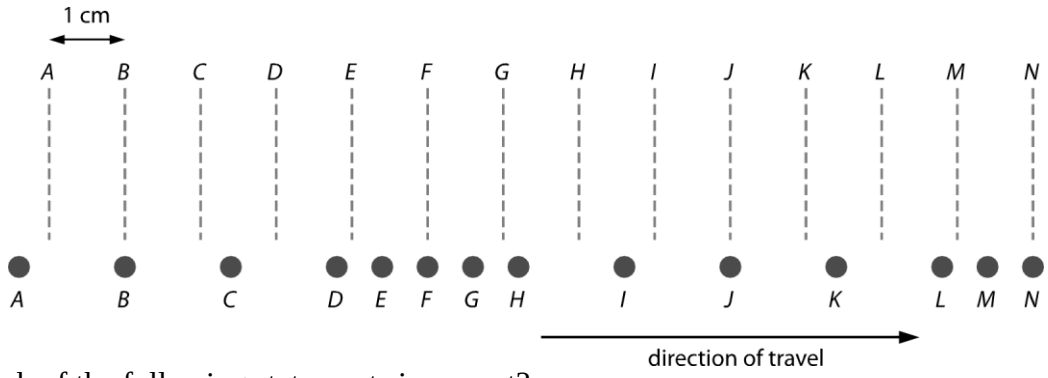
14. A stationary wave is developed along a light string. *W*, *X*, *Y* and *Z* are four points on the strings as shown.



At the instant shown, point *W* is momentarily at rest. After 3/4 period,

A. *W* is momentarily at rest.
B. *X* is moving with its maximum speed.
C. *Y* is moving downwards.
D. *Z* is moving downwards.

15. A wave travelling to the right passes a series of particles. The figure shows the positions of the particles at a certain instant. The equilibrium positions of the particles are indicated as dotted lines.

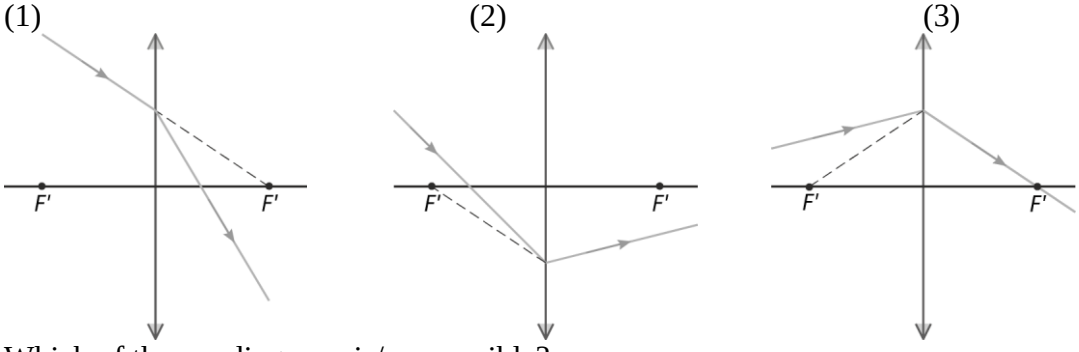


Which of the following statements is correct?

A. Particle *B* is always at rest.
B. Particle *L* is moving with its maximum speed.
C. The wavelength of the wave is 12 cm.
D. Particles *F* and *J* are out of phase.

16. Three light rays are incident on a convex lens as shown. *F* and *F'* are the two principal foci of the lens.

(1) (2) (3)



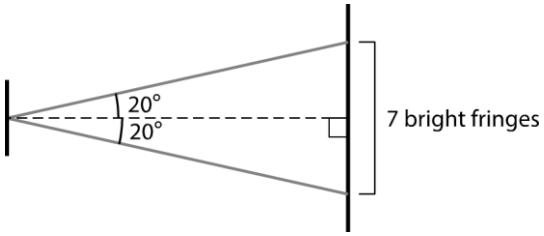
Which of the ray diagrams is/are possible?

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

17. An object placed 30.0 cm in front of a lens forms a virtual image twice as tall as the object. Is the lens concave or convex? What is its focal length?

	type	**focal length**
A.	concave	30 cm
B.	concave	60 cm
C.	convex	30 cm
D.	convex	60 cm

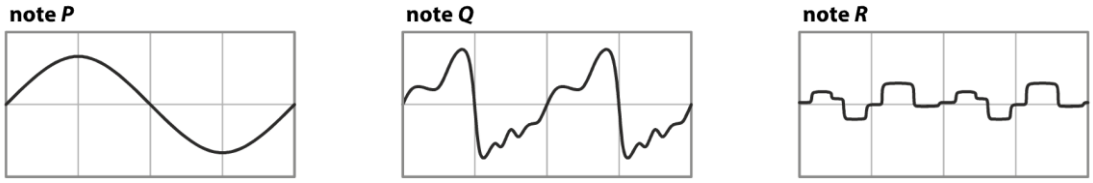
18. In a grating experiment, 7 bright fringes are observed on the screen. All these fringes subtend an angle of 40° at the centre of the grating, as shown.



If the wavelength of the light source is 405 nm, which of the following best estimates the number of slits per mm on the grating?

A. 120 B. 230
C. 280 D. 530

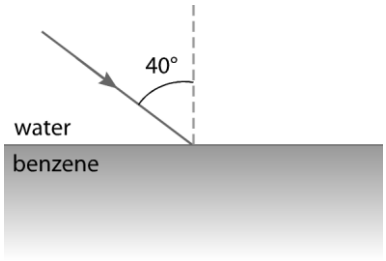
19. Below shows the CRO traces produced by three different notes. The settings of the CRO are the same.



Which pair of the above notes has the same pitch?

A. Notes *P* and *Q*
B. Notes *Q* and *R*
C. Notes *P* and *R*
D. They all have different pitches.

20. A light ray is incident to the boundary between water and benzene as shown. The refractive indices of water and benzene are 1.33 and 1.50 respectively. Find the value of refracted angle.



A. 34.7° B. 46.5°
C. 58.7° D. 74.6°

21. Two insulated metal spheres carry charge of the same magnitude. They were initially separated by a distance of d and the force between them is F_1. The spheres are then brought to touch each other momentarily and separated by a distance of d again. The force between them now is F_2. Which of the following statements **must** be correct?

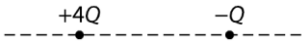
(1) F_2 has a magnitude smaller than or equal to F_1.
(2) If F_1 is attractive, F_2 is also attractive.
(3) If F_1 is repulsive, F_2 is also repulsive.

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

22. A length of uniform metal wire of resistance R is cut in half and the two lengths are wrapped together side by side to make a thicker wire. What is the resistance of this new wire?

A. $4R$ B. R
C. $R/2$ D. $R/4$

23. Point charges $+4Q$ and $-Q$ are fixed on a straight line as shown.

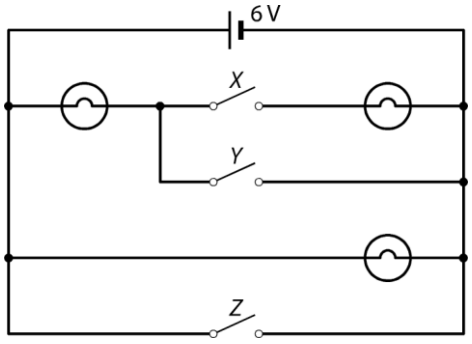


A positive test charge $+q$ is placed at a certain position on the straight line joining the two charges. At that position, the electric fields due to the two charges are equal in magnitude. If the test charge is released, which of the following subsequent motions of the test charge is/are possible?

(1) Remaining at rest
(2) Moving to the left
(3) Moving to the right

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

24. A 6 V battery is connected to three identical light bulbs of rating '6 V, 3 W' and three switches *X*, *Y* and *Z* as shown.

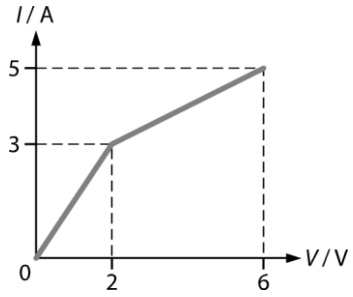


Which of the following combinations result in working of two light bulbs at their rated values?

	X	***Y***	***Z***
(1)	closed	open	closed
(2)	open	closed	open
(3)	closed	closed	open

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

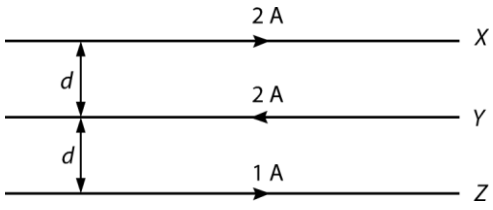
25. The graph below shows the *I*–*V* characteristic curve of a conductor.



Which of the following statements is/are correct?
(1) The conductor is an ohmic conductor when the voltage across it is less than 2 V.
(2) The resistance of the conductor is 1.5 Ω when the voltage across it is 1 V.
(3) The resistance of the conductor is 0.5 Ω when the voltage across it is 4 V.

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

26. Suppose two long parallel wires, each carrying a current of 1A and separated by a distance *d*, exert a force of *F* per unit length on each other. If three long parallel current-carrying wires *X*, *Y* and *Z* are set up in air in the same plane as shown below, what is the net force per unit length acting on wire *X*?

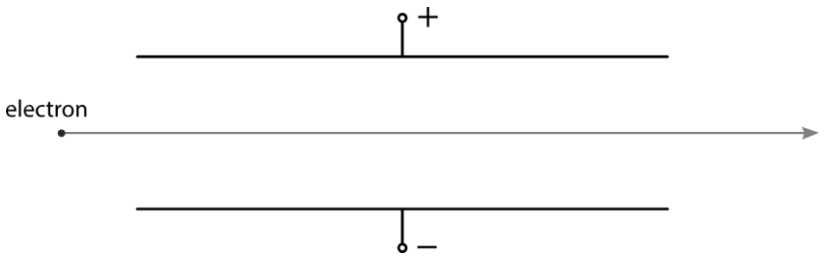


A. 0 B. *F* C. 2*F* D. 3*F*

27. A very long solenoid carrying a current has a uniform magnetic field of magnitude *B* at the centre of the solenoid. If the solenoid is slightly stretched and elongated by 5%, how does the magnitude of the magnetic field at the centre of the solenoid compare with that before?

A. decreases by 4.76%
B. decreases by 5.00%
D. increases by 5.00%
C. increases by 5.56%

28. An electron with kinetic energy *K* enters perpendicularly into a zone with uniform electric field *E*. A uniform magnetic field *B* is applied in the zone so that the electron goes straight through the zone without any deflection.



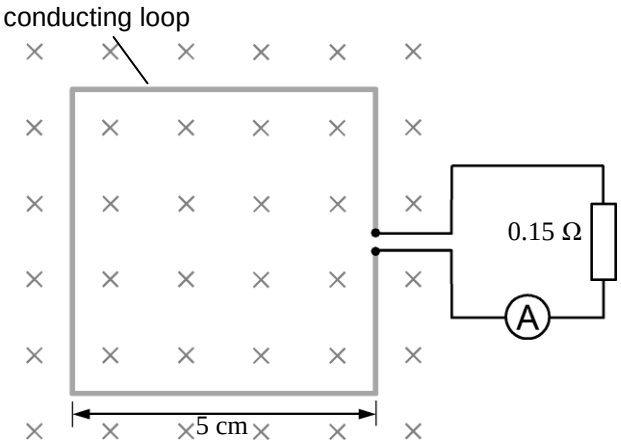
If the mass of an electron is *m*, which of the following descriptions about the magnetic field is correct?

	magnitude	**direction**
A.	$\sqrt{\frac{2K}{m}} \cdot E$	into the paper
B.	$\sqrt{\frac{m}{2K}} \cdot E$	into the paper
C.	$\sqrt{\frac{2K}{m}} \cdot E$	out of the paper
D.	$\sqrt{\frac{m}{2K}} \cdot E$	out of the paper

29. The input terminal of a transformer is connected to the mains, and its output terminal is connected to a resistor. The ratio of the number of turns on the primary coil to that on the secondary coil is 5 to 1. The power dissipated by the resistor is 80 W, and the current drawn from the mains is 0.6 A. Find the efficiency of the transformer.

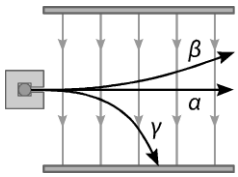
A. 25.7% B. 42.9%
C. 60.6% D. 72.4%

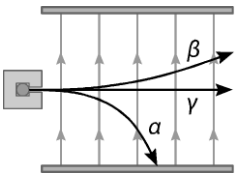
30. A square conducting loop, a 0.15 Ω resistor and an ammeter are connected into a circuit a shown. A uniform magnetic field is applied perpendicularly to the loop and its magnitude is decreasing at a constant rate of 6.00×10^{-2} T s^{-1}. Find the reading of the ammeter.

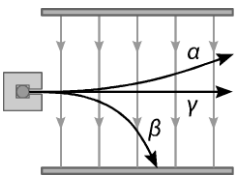


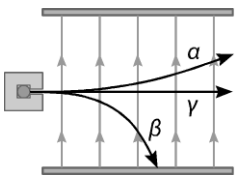
A. 1.00 mA B. 1.50 mA C. 2.00 mA D. 3.00 mA

31. A radioactive source emits α, β and γ radiations. The radiations are directed towards an electric field. Which of the following diagrams best shows the paths of the radiations in the field?

A.


B.


C.


D.


32. A GM counter is placed in front of an unknown radioactive source. Different absorbers are inserted between them in turn. The recorded count rates are listed in the table below.

Absorber	Recorded count rate / counts per minute
(nil)	697
paper	708
5 mm thick aluminium sheet	442
25 mm thick lead slab	236

Which kind(s) of radiation does the source emit?

A. β radiation only
B. α and β radiation only
C. β and γ radiation only
D. α, β and γ radiation

33. Pu-238 undergoes α decay to become U-234. The energy released during the decay can be used to power a nuclear heart pacemaker.

$$^{238}_{94}\text{Pu} \longrightarrow {}^{234}_{92}\text{U} + {}^{4}_{2}\text{He}$$

Given: mass of Pu-238 = 238.049 560 u
mass of U-234 = 234.040 952 u
mass of He-4 = 4.002 603 u
mass of He-2 = 2.015 894 u
activity of 1 g of Pu-238 = 634×10^9 Bq

Suppose a heart pacemaker requires a power input of 10 mW. How many grams of Pu-238 are required to power the heart pacemaker?

A. 0.002 82 g
B. 0.0176 g
C. 0.352 g
D. 1.79 g

END OF SECTION A

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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^{-1}

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
$\left\|\frac{\Delta f}{f_0}\right\| \approx \frac{v}{c} \approx \left\|\frac{\Delta\lambda}{\lambda}\right\|$	Doppler effect

Energy and Use of Energy

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

Atomic World

$\frac{1}{2}m_c {v_{max}}^2 = hf - \phi$	Einstein's photoelectric equation
$E_n = -\frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\epsilon_0^2}\right\} = -\frac{13.6}{n^2}\text{eV}$	energy level equation for hydrogen atom
$\lambda = \frac{h}{p} = \frac{h}{mv}$	de Broglie formula
$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)

Medical Physics

$\theta \approx \frac{1.22\lambda}{d}$	Rayleigh criterion (resolving power)
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.	$E = \ell \Delta m$	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.	$E_{\mathrm{K}} = \frac{3RT}{2N_{\mathrm{A}}}$	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.	$E_{\mathrm{P}} = mgh$	gravitational potential energy
B4.	$E_{\mathrm{K}} = \frac{1}{2}mv^2$	kinetic energy
B5.	$P = Fv = \frac{W}{t}$	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.	$F = \frac{Q_1Q_2}{4\pi\epsilon_0 r^2}$	Coulomb's law
D2.	$E = \frac{Q}{4\pi\epsilon_0 r^2}$	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.	$\frac{V_{\mathrm{S}}}{V_{\mathrm{P}}} \approx \frac{N_{\mathrm{S}}}{N_{\mathrm{P}}}$	ratio of secondary voltage to primary voltage in a transformer
E1.	$N = N_0 \mathrm{e}^{-kt}$	law of radioactive decay
E2.	$t_{½} = \frac{\ln 2}{k}$	half-life and decay constant
E3.	$A = kN$	activity and the number of undecayed nuclei
E4.	$E = mc^2$	mass–energy relationship