Name: _____ **Class:** _____

JURONG PIONEER JUNIOR COLLEGE

JC2 Preliminary Examination 2023

PHYSICS **9749/01**

Higher 2 **19 September 2023**

Paper 1 Multiple Choice **1 hour**

Additional Material: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **20** printed pages.

Data

speed of light in free space	$c = 3.00 \times 10^{8}$ m s^{-1}
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ F m^{-1}
	$= (1/(36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
molar gas constant	$R = 8.31$ J K^{-1} mol^{-1}
the Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}
the Boltzmann constant	$k = 1.38 \times 10^{-23}$ J K^{-1}
gravitational constant	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}
acceleration of free fall	$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
hydrostatic pressure	$p = \rho gh$
gravitational potential	$\phi = -\frac{GM}{r}$
temperature	$T / \mathrm{K} = T / {}^\circ\mathrm{C} + 273.15$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas molecule	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$ $= \pm\omega\sqrt{x_0{}^2 - x^2}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + ...$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + ...$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
alternating current/voltage	$x = x_0 \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_0 NI}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_0 nI$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

1 The radiancy R is defined as the total energy emitted per unit time per unit area from a black body at thermodynamic temperature T. It is given by

$$R = \sigma T^4$$

where σ is called the Stefan-Boltzmann constant.

What is the correct unit for σ?

A W m^{-2} K^4

B kg s^{-3} K^{-4}

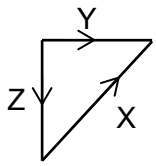
C J s m^{-2} K^{-4}

D J s^{-1} m^{-2} K^4

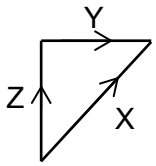
2 Two vectors X and Y are shown in the given diagram.

In which vector diagram does the vector Z represent the difference between X and Y such that Z = X – Y?

A



B



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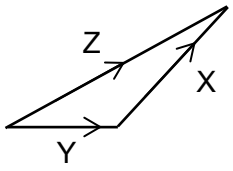

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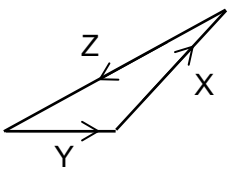
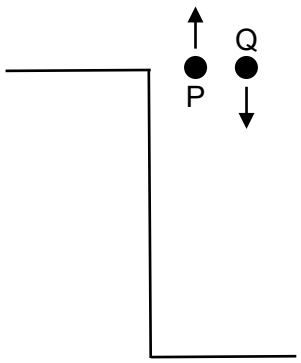


3 Two stones P and Q are thrown from the top of a cliff, one straight up and the other straight down, at the same initial speed. Both eventually hit the ground.



The effect of air resistance on the stones is negligible.

Which statement will be true of the speeds with which the stones hit the ground?

A Stone P hits the ground with the greater speed.

B Stone Q hits the ground with the greater speed.

C Both stones hit the ground with the same speed.

D The comparative speeds of impact depend on the height of the cliff.

4 An object accelerates uniformly from rest in a straight line.

During the first 10 seconds it travels a total distance of 24 m.

What is distance travelled by the object in the next 15 s?

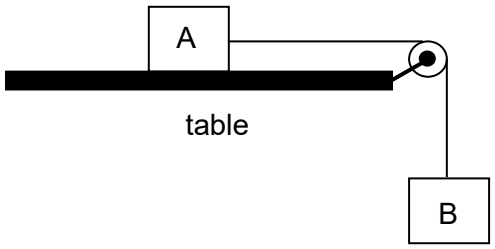
A 36 m

B 54 m

C 126 m

D 150 m

5 Two blocks A and B of masses 2.0 kg and 5.0 kg respectively are connected by an inextensible string as shown.



Both the table and the pulley are frictionless.

When B is released, what is the acceleration of A?

A 7.0 m s^{-2}

B 9.8 m s^{-2}

C 16 m s^{-2}

D 25 m s^{-2}

6 Two masses m and $3m$ move towards each other in opposite directions with speeds $2v$ and v respectively.

The masses collide and stick together.

What is the speed of mass m after the collision?

A $\frac{v}{4}$

B $\frac{v}{2}$

C v

D $\frac{5v}{4}$

7 A boat floating in fresh water displaces 35.6 kN of water.

The density of sea water is 1024 kg m^{-3}.

What is the volume of sea water it will displace when floating in the sea?

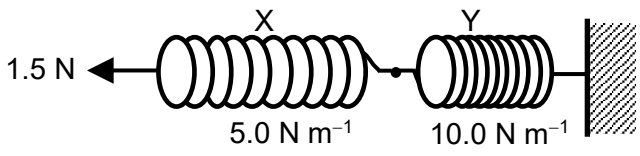
A 3720 m^3

B 34.8 m^3

C 3.63 m^3

D 3.54 m^3

8 A spring X of force constant 5.0 N m^{-1} is connected in series with a spring Y of force constant 10.0 N m^{-1} as shown. A force of 1.5 N is applied to the other end.



What is the total elastic potential energy stored in the springs?

A 0.23 J

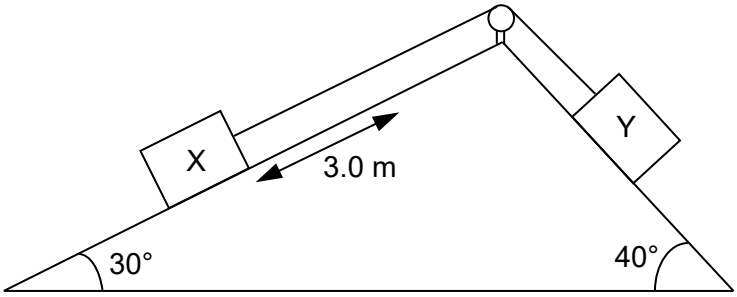
B 0.34 J

C 0.68 J

D 1.5 J

9 Two boxes X and Y of masses 2.0 kg and 3.0 kg respectively are connected by a light inextensible rope passing over a smooth pulley. X and Y are on smooth inclined planes.

X starts from rest and moves up the plane inclined at 30° to the horizontal.



What will be the final speed of Y after X has travelled 3.0 m along the plane?

A 1.6 m s^{-1}

B 2.3 m s^{-1}

C 3.3 m s^{-1}

D 4.3 m s^{-1}

10 A mass m_1 is attached to one end of an elastic string of an unstretched length L. When the mass is rotating with a linear speed v on a smooth table in a horizontal circle, an extension e is obtained.

A second mass m_2 rotates with the same linear speed v. The radius is twice that produced by m_1.

What is the mass m_2?

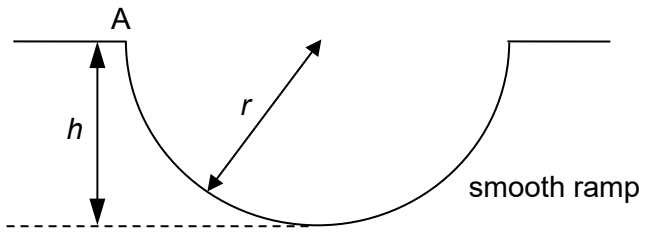
A $\dfrac{2m_1(L+e)}{e}$

B $\dfrac{2m_1(L+2e)}{e}$

C $\dfrac{2m_1(2L+e)}{e}$

D $\dfrac{2m_1(2L+2e)}{e}$

11 A skateboarder rests on top of a smooth ramp of height h and radius of curvature r. He moves off from his position of rest at A and slides down the smooth ramp.



The mass of the skateboarder is m.

What is the magnitude of the contact force R exerted by the ramp on the skateboarder at the lowest point of the ramp?

A mg

B $2mg$

C $3mg$

D $4mg$

12 A satellite of mass 50 kg moves from a point where the gravitational potential due to the Earth is −30 MJ kg^{-1} to another point where the gravitational potential is −70 MJ kg^{-1}.

During this change of position, it has moved

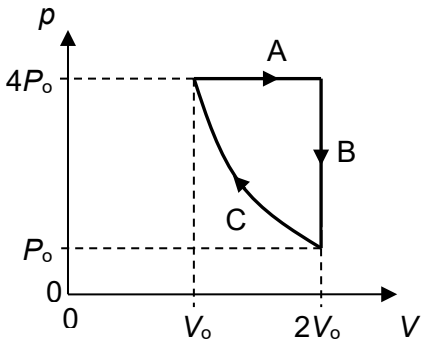
A closer to the Earth and lost 2000 MJ of potential energy.

B closer to the Earth and lost 40 MJ of potential energy.

C further from the Earth and gained 2000 MJ of potential energy.

D further from the Earth and gained 40 MJ of potential energy.

13 A fixed mass of ideal gas undergoes changes in pressure p and volume V starting with process A, as shown.



Which statement about the processes is **not** necessarily true?

A Temperature of the gas is doubled in process A.

B Work done by the gas in process A is $4P_oV_o$.

C Heat is removed from the system in process B.

D There is no heat exchange in process C.

14 In an ideal gas at 200 °C, the molecules are travelling at a root-mean-square speed v.

Both the pressure and volume of the gas are then tripled.

What are the temperature of the gas and the root-mean-square speed of the molecules?

	temperature / °C	root-mean-square speed of molecules
A	1800	$3v$
B	1800	$9v$
C	4000	$3v$
D	4000	$9v$

15 Which statement about a simple harmonic oscillator is correct?

A The maximum kinetic energy of the oscillator is proportional to the frequency of its motion.

B The potential energy of the oscillator is minimum when the oscillator is momentarily at rest.

C The kinetic energy of the oscillator is zero when the oscillator is at the equilibrium position.

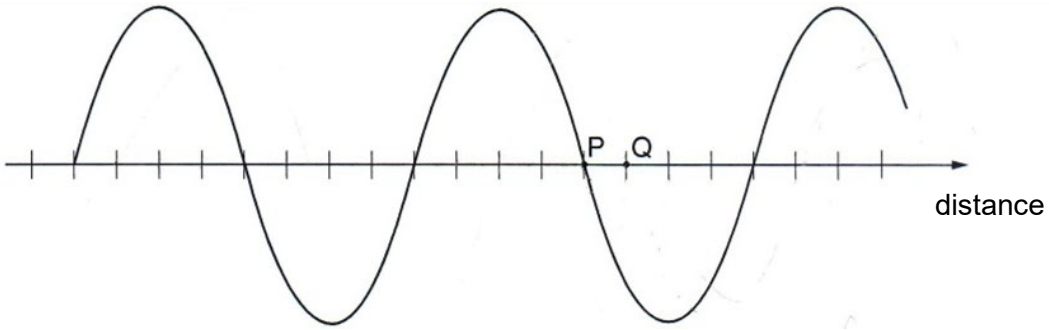
D When the kinetic energy of the oscillator is equal to its potential energy, the oscillator is neither at the rest position nor at the maximum displacement positions.

16 A body performs simple harmonic motion with a period of 0.063 s. The maximum speed of the body is 3.0 m s^{-1}.

What are the values of the amplitude x_0 and maximum acceleration a_0?

	x_0 / m	a_0 / m s^{-2}
A	0.030	3.0
B	0.030	300
C	0.19	19
D	0.19	1900

17 The diagram shows a transverse wave at a particular instant. The wave is travelling to the right. The frequency of the wave is 12.5 Hz.



At the instant shown the displacement is zero at the point P.

What is the shortest time to elapse before the displacement is zero at point Q?

A 0.010 s

B 0.030 s

C 0.080 s

D 0.100 s

18 A musical instrument is made using a long tube with a mouthpiece at one end. The other end is open and flared, as shown.

A musician maintains stationary sound waves with a node at the mouthpiece and an antinode at the other end. The lowest frequency of sound that the instrument can produce is 98 Hz.

Which different frequencies of sound can be produced by the instrument?

A 98 Hz, 147 Hz, 196 Hz, 245 Hz

B 98 Hz, 196 Hz, 294 Hz, 392 Hz

C 98 Hz, 196 Hz, 392 Hz, 588 Hz

D 98 Hz, 294 Hz, 490 Hz, 686 Hz

19 An optical telescope just resolves two distant yellow stars. They are subtended at an angle of 2.0×10^{-6} radians at the telescope. The wavelength of yellow light is about 590 nm.

Which statement is correct?

A The aperture of the telescope has a diameter of about 0.30 m.

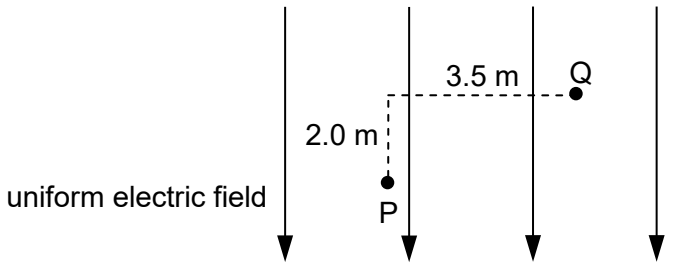
B The telescope can be used to distinguish two red stars at similar distance.

C The resolving power of the telescope is independent of the wavelength of light.

D The telescope can be used to distinguish stars subtended at an angle of 3.0×10^{-7} radians.

20 A −5.0 C point charge is initially stationary at a point P in a uniform electric field of field strength 4.0 V m^{-1}.

It is then moved within the field 2.0 m parallel to the field and 3.5 m perpendicular to the field to a point Q as shown.



What is the work done against the electric field?

A −40 J

B 40 J

C −70 J

D 70 J

21 An electron of charge *e* and mass m_e enters through a hole into a space between two parallel metal plates AB and CD, separated by a distance *d*.

CD is maintained at a positive potential *V* relative to AB.

The velocity of the electron is *v*.

Which expression is correct for the electron to just reach AB?

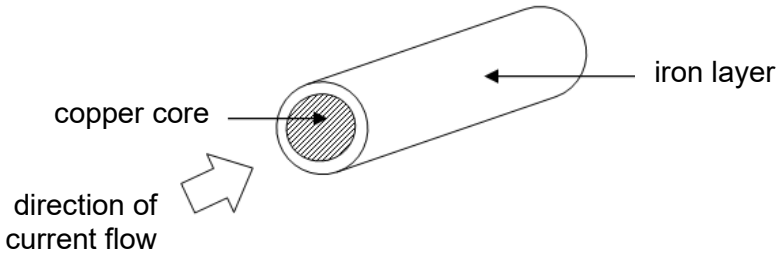
A $\frac{1}{2}m_e v^2 = \frac{e}{4\pi\varepsilon_o d}$

B $\frac{1}{2}m_e v^2 = eV$

C $\frac{1}{2}m_e (v\cos\theta)^2 = eV$

D $\frac{1}{2}m_e (v\sin\theta)^2 = eV$

22 A resistor is made of a copper cylindrical core of cross-sectional area $2.0 \times 10^{-3}\,m^2$ which is surrounded by iron of cross-sectional area $1.0 \times 10^{-3}\,m^2$.



The resistivities of copper and iron are $1.7 \times 10^{-8}\ \Omega$ m and $1.0 \times 10^{-7}\ \Omega$ m respectively.

What is the resistance per unit length of such a resistor?

A $7.8 \times 10^{-6}\,\Omega\,m^{-1}$

B $8.5 \times 10^{-6}\,\Omega\,m^{-1}$

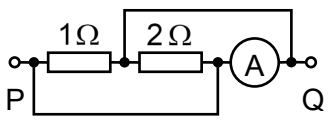
C $8.3 \times 10^{-5}\,\Omega\,m^{-1}$

D $9.2 \times 10^{-5}\,\Omega\,m^{-1}$

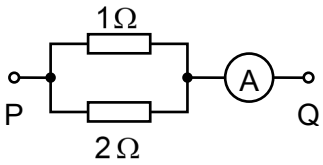
23 In each arrangement of resistors, the ammeter has a resistance of 3 Ω.

Which arrangement gives the smallest reading on the ammeter when the same potential difference is applied between points P and Q?

A



B



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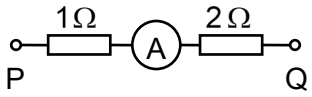

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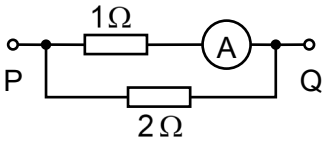
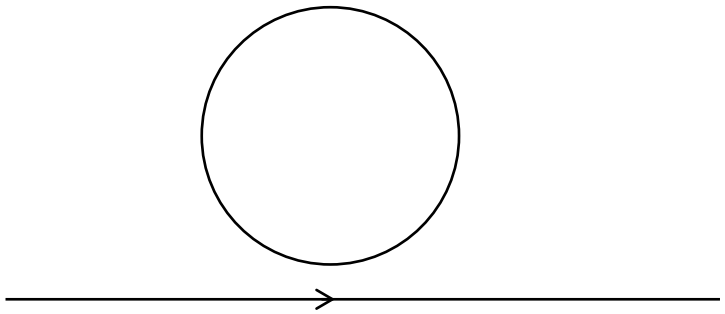


24 A charged particle is projected with velocity v into an evacuated region. A uniform electric field of field strength E and a uniform magnetic field of flux density B are applied perpendicular to each other in the same evacuated region.

If the velocity v is to stay constant, what is its magnitude and direction?

	magnitude	direction
A	$\frac{B}{E}$	parallel to B
B	$\frac{E}{B}$	parallel to E
C	$\frac{B}{E}$	perpendicular to both B and E
D	$\frac{E}{B}$	perpendicular to both B and E

25 A current carrying wire is placed below a vertical coil in its plane, with current flowing towards the right as shown.



Which statement correctly describes the possible effect on the coil when the current in the wire increases?

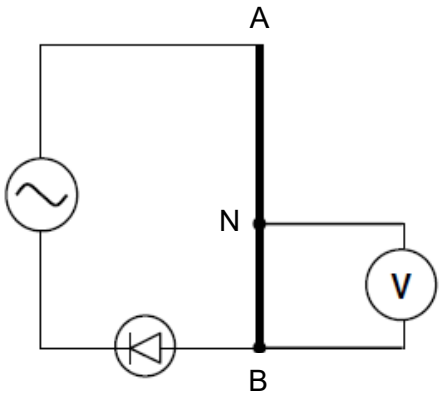
A No current will be induced in the coil.

B A clockwise current will be induced in the coil.

C An anti-clockwise current will be induced in the coil.

D The current induced in the coil will be first anticlockwise and then clockwise.

26 The uniform wire AB has length 1.0 m and resistance of 10 Ω. It is connected in series with an a.c. supply and an ideal diode.



When NB is 40 cm, the a.c. voltmeter gives a steady reading of 2.5 V.

What is the instantaneous peak power provided by the supply?

A 0.63 W

B 3.9 W

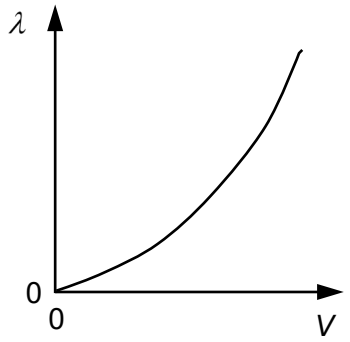
C 7.8 W

D 16 W

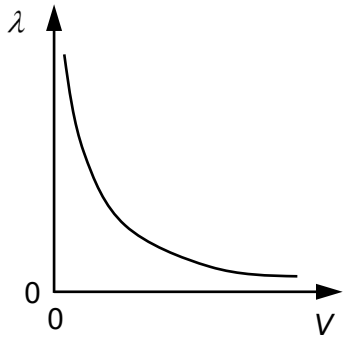
27 Electrons are accelerated from rest through a potential difference V.

Which graph shows the variation of the de Broglie wavelength λ of the electrons with V?

A



B



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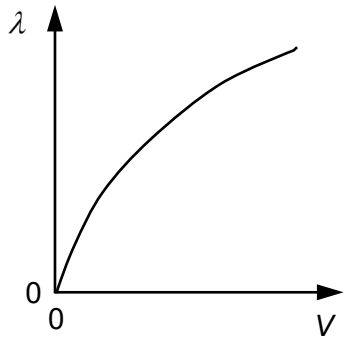

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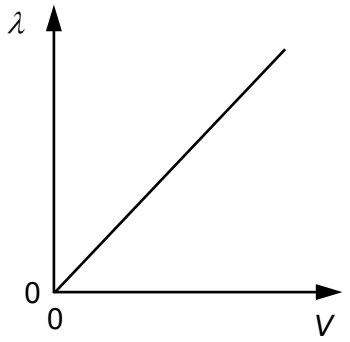
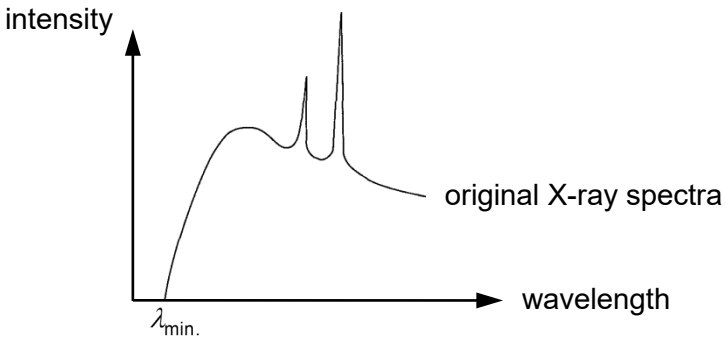


28 The graph shows the spectrum of X-rays emitted from an X-ray tube.



The potential difference between the target and cathode is increased.

How do the minimum wavelength and the wavelengths of the peaks change?

	minimum wavelength	wavelengths of peaks
A	decrease	increase
B	decrease	remain the same
C	increase	increase
D	increase	remain the same

29 In the absence of any radioactive source, the average value of the background radiation is found to be 30 counts per second.

When a radioactive source with half-life of 5 hours is placed at a fixed distance from the counter, the average total count rate is 210 counts per second.

What average count rate is expected with the source in the same position 10 hours later?

A 45 s^{-1}

B 53 s^{-1}

C 60 s^{-1}

D 75 s^{-1}

30 Which isotope decays by emission of a β-particle to produce $^{111}_{48}\text{Cd}$?

A $^{111}_{47}\text{Ag}$

B $^{110}_{47}\text{Ag}$

C $^{111}_{49}\text{In}$

D $^{112}_{50}\text{Sn}$

End of paper