H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
CLASS		TUTOR'S NAME	
CENTRE NUMBER	S	INDEX NUMBER	

PHYSICS 9749/01

Paper 1 Multiple Choice **20 September 2022**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class, Centre number and index number in the spaces at the top of this page.

There are **thirty** questions on 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 **16** 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	$\phi = -Gm / r$
temperature	$T / \text{K} = T / {}^\circ\text{C} + 273.15$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
mean translational kinetic energy of an ideal 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	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
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 Which of the following is not a reasonable estimate?

A Sound of frequency in the order of 10^9 Hz is audible to human beings.

B Light of wavelength in the order of 10^{-7} m is visible to human beings.

C The volume of an average-sized orange is in the order of 10^{-4} m^3.

D The speed of beta particles emitted from a nucleus is in the order of 10^7 m s^{-1}.

Ans: A

Options B and D are typical values that candidates should be familiar with. Using $V = \frac{4}{3}\pi r^3$, Option C works out for an orange having radius of about 5 cm. The frequency of sound (or even ultrasound) cannot hit GHz range.

2 The kinetic energy E_K of a rotating solid sphere is given by the following expression

$$E_k = \frac{2\pi^2 I}{T^2}$$

where I is the moment of inertia and T is the period of rotation of the solid sphere.

What is the unit for the moment of inertia I, expressed in SI base units?

A kg m^2 s^{-1}

B kg m^2

C J s^2

D N m s^2

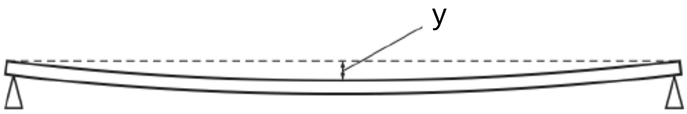
Ans: B

$$E_K = \frac{2\pi^2 I}{T^2}$$

$$I = \frac{E_K T^2}{2\pi^2}$$

$$\begin{aligned}\text{unit for } I &= (\text{unit for } E_K)(\text{unit for } T)^2 \\ &= \{\text{unit for } (mv^2)\}(\text{unit for } T)^2 \\ &= (\text{kg})(\text{m}^2\ \text{s}^{-2})(\text{s}^2) \\ &= \text{kg m}^2\end{aligned}$$

3 A ruler is supported horizontally by two pivots as shown.



The vertical displacement y at the centre of the ruler can be used to measure the mass loaded on it and is given by the equation

$$y = \frac{kML^3}{wt^3}$$

where

k is a constant,
L is the distance between the pivots,
M is the mass loaded onto the ruler,
t is the thickness of the ruler and
w is the width of the ruler.

When a particular M is loaded onto the ruler, the following results are obtained:

$$y = (0.25 \pm 0.01)\ \text{mm}$$
$$L = (80.0 \pm 0.2)\ \text{cm}$$
$$t = (6.0 \pm 0.1)\ \text{mm}$$
$$w = (23.0 \pm 0.5)\ \text{mm}$$

Which measurement contributes the most to the uncertainty of M?

A y **B** L **C** t **D** w

Ans: C

Make M subject of formula:

$$M = \frac{ywt^3}{kL^3}$$

$$\frac{\Delta M}{M} = \frac{\Delta y}{y} + \frac{\Delta w}{w} + 3\frac{\Delta t}{t} + 3\frac{\Delta L}{L}$$

$$\frac{\Delta y}{y} = \frac{0.01}{0.25} = 0.040$$

$$\frac{\Delta w}{w} = \frac{0.5}{23.0} = 0.022$$

$$3\frac{\Delta t}{t} = 3\frac{0.1}{6.0} = 0.050$$

$$3\frac{\Delta L}{L} = 3\frac{0.2}{80.0} = 0.0075$$

4 The speed of an aeroplane in still air is 200 km h^{-1}. The wind pushes it from the west at a speed of 85.0 km h^{-1}.

In which direction must the pilot steer in order to fly due north?

A 23.0° east of north

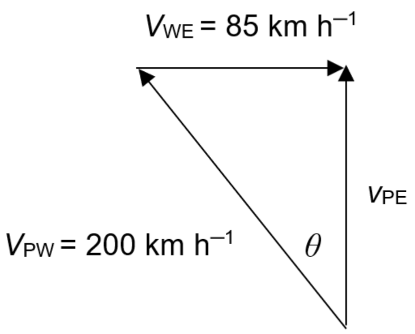
B 23.0° west of north

C 25.2° east of north

D 25.2° west of north

Ans: D

$v_{PE} = v_{PW} + v_{WE}$ where v_{PE} is velocity of plane relative to Earth
v_{PW} is velocity of plane relative to Wind
v_{WE} is velocity of wind relative to Earth

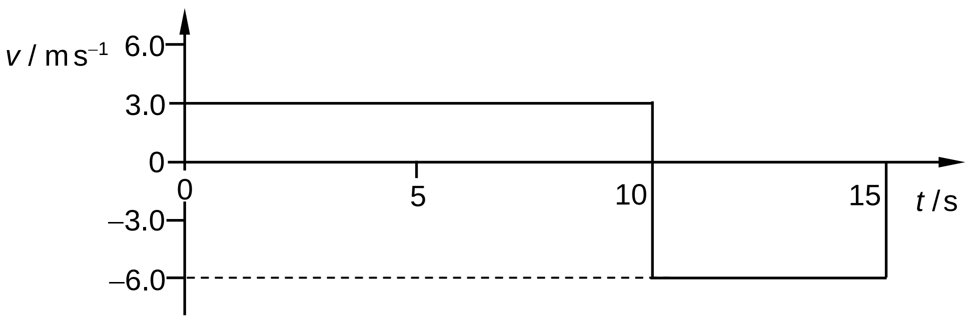


$\sin\theta = 85/200$

θ = 25.2° west of north

5 A radio-controlled toy car travels along a straight line for a time of 15 s.

The variation with time t of the velocity v of the car is shown below.



What is the average velocity of the toy car for the 15 s journey?

A –1.5 m s^{-1} **B** 0.0 m s^{-1} **C** 4.0 m s^{-1} **D** 4.5 m s^{-1}

Area under the graph = Δs = zero

$v_{ave} = \Delta s/t = 0$

Answer: B

6 A tennis ball is thrown horizontally in air from the top of a tall building. The effect of air resistance is not negligible.

Which of the following correctly describes the subsequent change in the horizontal and vertical components of the ball's velocity?

	horizontal component of velocity	vertical component of velocity
A	constant	constant
B	constant	increases at a constant rate
C	decreases to zero	increases at a constant rate
D	decreases to zero	increases to a maximum value

Since the building is tall, the time of flight is long enough for the vertical component of velocity to reach a maximum value.

Answer: D

7 A rock of mass 2*m* in deep space, initially travelling at velocity *v*, explodes into two parts of equal mass, one of which becomes stationary immediately after the explosion.

What is the kinetic energy of the moving part after the explosion?

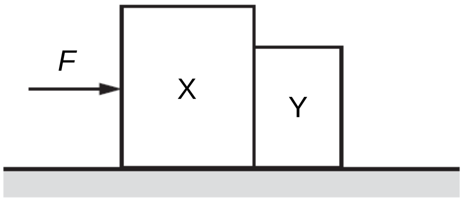
A $\frac{1}{2}mv^2$ **B** mv^2 **C** $\frac{3}{2}mv^2$ **D** $2mv^2$

By COM, momentum after explosion = 2mv, which is only carried by moving part.

So KE of moving part = $(2mv)^2/(2m) = 2mv^2$

Answer: D

8 A single horizontal force *F* is applied to a block X which is in contact with a separate block Y, as shown.



The blocks remain in contact as they accelerate along a horizontal frictionless surface. X has a greater mass than Y.

Which statement is correct?

A The acceleration of X is equal to force *F* divided by the mass of X.

B The force that X exerts on Y is equal to *F*.

C The force that X exerts on Y is less than *F*.

D The force that X exerts on Y is less than the force that Y exerts on X.

Answer: C

A: wrong. Acceleration of X = (F – $F_{\text{by Y on X}}$) divided by mass of X

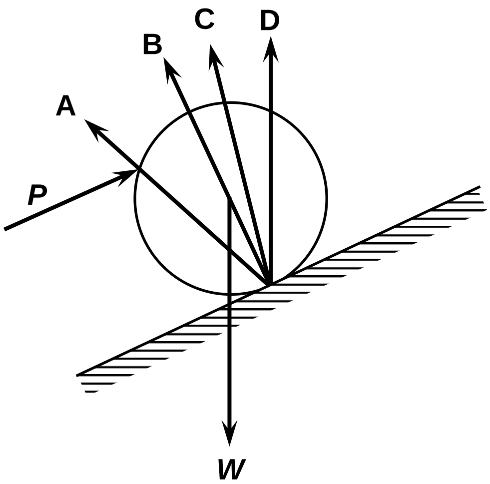
B: wrong. $F_{\text{by X on Y}}$ is equal in magnitude with $F_{\text{by Y on X}}$. If $F_{\text{by Y on X}}$ = F, net force on X = 0 and X will not accelerate.

C: correct. $F_{\text{by X on Y}}$ is equal in magnitude with $F_{\text{by Y on X}}$. If $F_{\text{by Y on X}}$ is less than F, net force on X acts in the direction of F and X will accelerate.

D: wrong. By N3L, $F_{\text{by X on Y}}$ is equal in magnitude with $F_{\text{by Y on X}}$.

9 A full barrel of weight *W* is being rolled up a ramp. The force *P* is required to hold the barrel at rest on the ramp. Friction between the barrel and the ramp stops the barrel from slipping.

Which arrow shows the resultant force that the ramp exerts on the barrel?

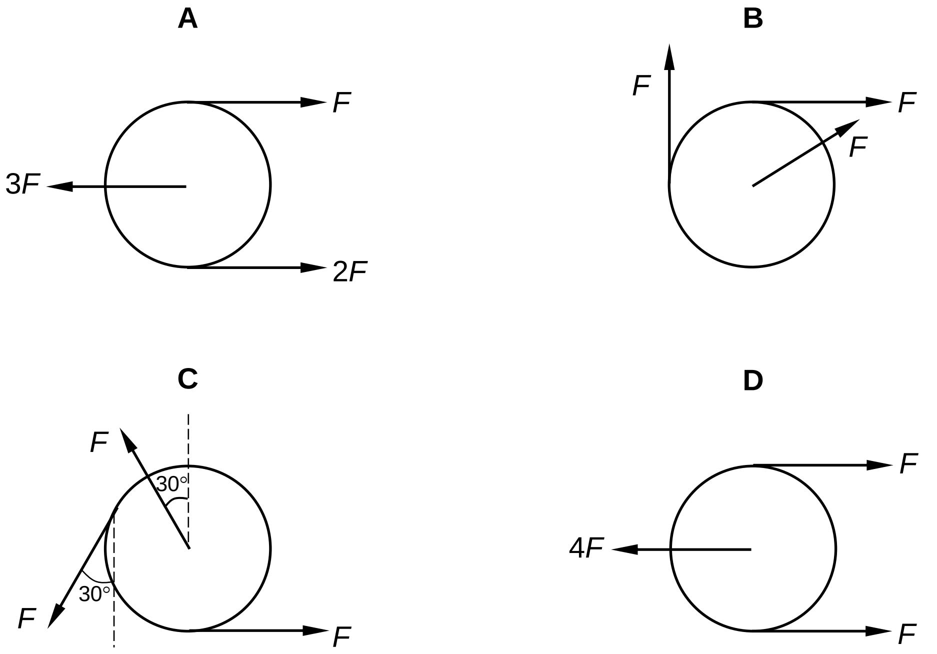


The line of action of the 3 forces need to intersect at a common point for rotational equilibrium.

Answer: C

10 An isolated disc is subjected to three forces, each given in terms of units of magnitude *F.*

In which situation will the disc experience both a resultant force and a resultant torque?

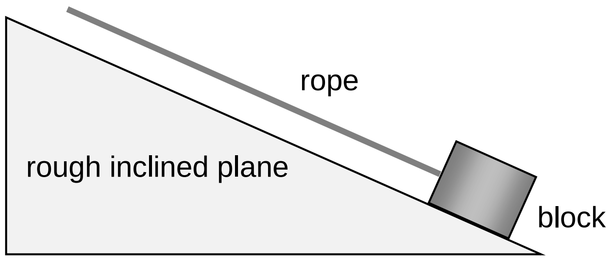


Check for ΣFx ≠ 0 OR ΣFy ≠ 0 for non-zero resultant force .

Check for resultant moment about centre of disc is non-zero.

Answer: B

11 A block is being pulled up a rough inclined plane using a rope at a constant speed.



Which of the following statements is correct?

A The weight of the block does no work because the block is not moving in the direction of its weight.

B The work done by the force of the rope is equal to the work done against the frictional force from the plane because there is no gain in kinetic energy.

C The normal reaction force from the plane does positive work because it has an upward component and the block is moving upwards.

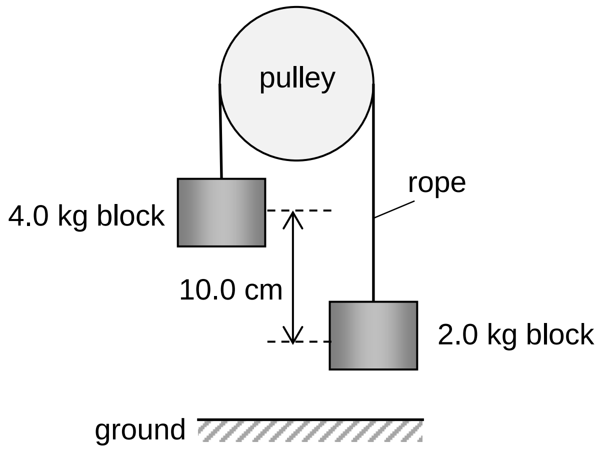
D The negative work done by the weight of the block is equal to the gain in gravitational potential energy of the block.

Ans: D

A force does no work when it is perpendicular to the direction of motion. (A & C)

Net work done on the block is positive because there is gain in GPE of the block. (B)

12 The figure below shows a light inextensible rope that passes over a light smooth pulley with two blocks of masses 4.0 kg and 2.0 kg attached to its two ends. The two blocks are initially at rest with the 4.0 kg block 10.0 cm above the 2.0 kg block.



What is the speed of the blocks when they are at the same height above the ground?

A 0.57 m s^{-1} **B** 0.81 m s^{-1} **C** 0.99 m s^{-1} **D** 1.4 m s^{-1}

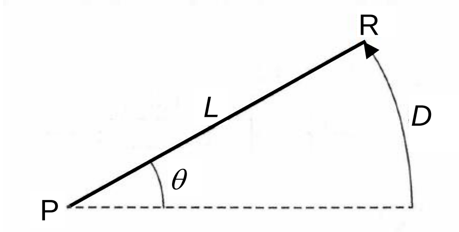
Ans: A

Loss in GPE = $4.0 \times 9.8 \times (5.0\times10^{-2}) - 2.0 \times 9.8 \times (5.0\times10^{-2}) = 0.98$ J

Gain in KE = $\frac{1}{2} \times (2.0 + 4.0) \times v^2 = 0.33$ J

→ $v = 0.57$ m s^{-1}

13 A rod PR of length L is turned about the point P through an angle θ.



The end R of the rod moves through a distance D. Both D and L are measured in metres.

What is the angle θ, expressed in radians?

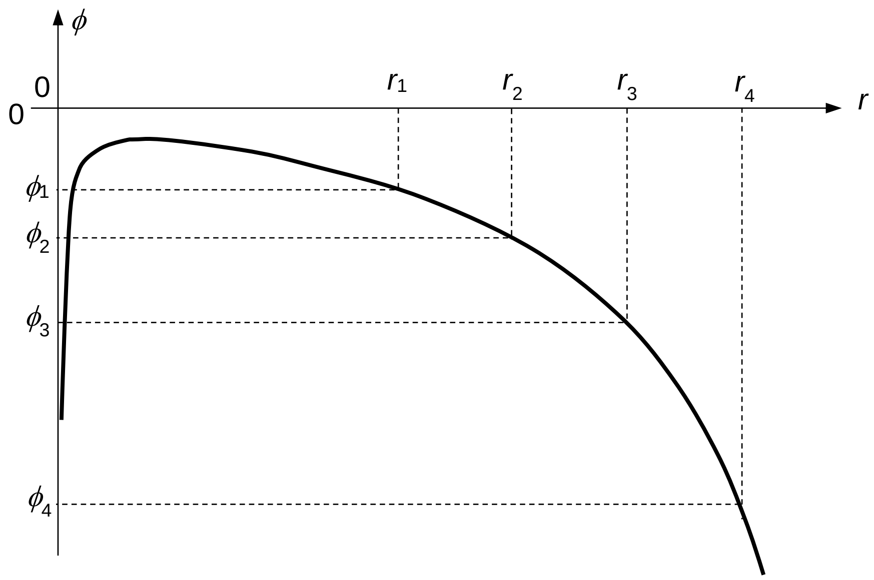
A L/D **B** D/L **C** DL **D** $1/(DL)$

Answer: B

$D = L\theta$

$\theta = (D / L)$ rad

14 The gravitational potential ϕ along the line joining the centres of a planet and its moon varies with the distance r from the centre of the moon as shown.



Which of the following expressions gives a value that is closest to that of the gravitational force acting on a 1 kg mass at a distance of r_2?

A $\dfrac{\phi_1 - \phi_2}{r_2 - r_1}$

B $-\dfrac{\phi_2}{r_2}$

C $\dfrac{\phi_1 - \phi_3}{r_3 - r_1}$

D $\dfrac{\phi_1 - \phi_4}{r_4 - r_1}$

Ans: C

$$F = -\frac{dE_p}{dr} = -m\frac{d\phi}{dr} \approx -1 \times \frac{\Delta\phi}{\Delta r}$$

Option A: Underestimated the gradient.

Option B: Incorrectly used $g = \dfrac{\phi}{r}$ .which is applicable only for a radial field. Here the *g*-field is the vector sum of the *g*-field due to the moon and the *g*-field due to the planet. The net field is not radial.

Option D: Overestimated the gradient.

15 Earth has a mass *M* and radius *R*. X is a point 5*R* from the center of the Earth.

An object of mass *m* falls freely from rest at X and hits the surface of the Earth.

Which of the following statements is false?

A The change in gravitational potential is $\frac{4}{5}\frac{GM}{R}$.

B The work done by the gravitational field is $\frac{4}{5}\frac{GMm}{R}$.

C The speed of impact is $\sqrt{\frac{8}{5}\frac{GM}{R}}$.

D The change in the magnitude of gravitational field strength is $\frac{24}{25}\frac{GM}{R^2}$.

Ans: A

Option A is an incorrect statement because as the object is falling, it should lose gravitational potential and hence the change should take on a negative value.

Change in gravitational potential $= \phi_{final} - \phi_{initial}$

$$= -\frac{GM}{R} - \left(-\frac{GM}{5R}\right)$$

$$= -\frac{4GM}{5R}$$

Option B is correct statement because the direction of gravitational force and displacement of object is the same. Hence work done by gravitational field is positive. The amount of work done by gravitational field will be the same as the amount of GPE loss in the fall.

Option C is correct statement because

Loss in GPE = Gain in KE

$$GPE_{initial} - GPE_{final} = KE_{final} - KE_{initial}$$

$$-\frac{GMm}{5R} - \left(-\frac{GMm}{R}\right) = \frac{1}{2}mv^2$$

$$\frac{4GMm}{5R} = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{8GM}{5R}}$$

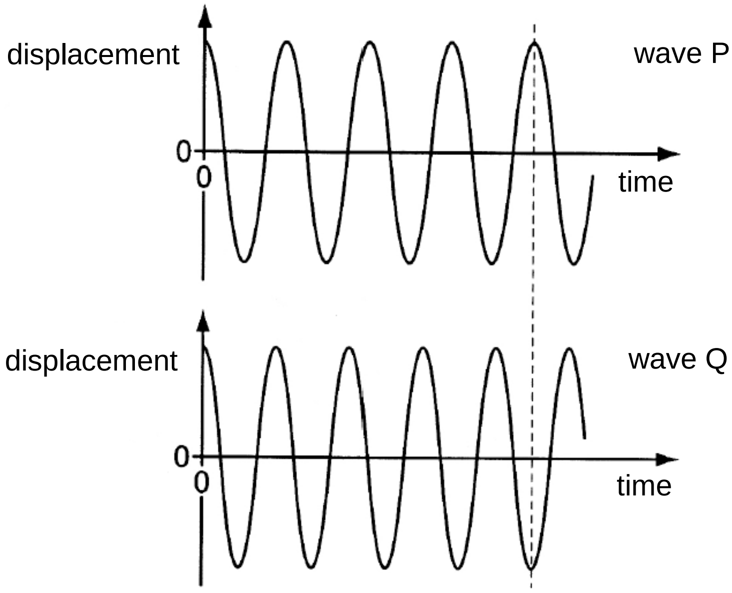
Option D is correct

Change in gravitational field strength $= g_{final} - g_{initial}$

$$= \frac{GM}{R^2} - \left(\frac{GM}{(5R)^2}\right)$$

$$= \frac{24GM}{25R^2}$$

16 The diagram shows the displacement-time graphs of two sound waves P and Q at a point in space. The graphs have the same scales for the time axes.



The frequency of Q is 125 Hz. The waves are in phase at time = 0.

At what time are the waves next in phase?

A 32 ms **B** 36 ms **C** 64 ms **D** 72 ms

Ans: D

From graphs shown,

P and Q are initially in phase at t = 0, and become out of phase next at t = $4.5T_Q$, where T_Q is the period of wave Q.

$T_Q = 1/f_Q = 1/125$ s

Hence the next time the waves become in phase must be for another duration of 4.5 T_Q,

i.e. they are next in phase at time

t = 4.5 T_Q + 4.5 T_Q = 9 T_Q = 0.072 s

17 Which of the following correctly states the changes, if any, in the potential energy and kinetic energy of the molecules of a solid as it melts?

	potential energy	kinetic energy
A	decreases	increases
B	increases	remains the same
C	remains the same	decreases
D	remains the same	remains the same

temperature is constant when the solid melts

Answer: B

18 The frequency of a wave is 600 Hz and its speed is 330 m s^{-1}.

What is the phase difference between the oscillation of two points on the wave that are 0.275 m apart?

A 0 **B** $\frac{\pi}{4}$ rad **C** $\frac{\pi}{2}$ rad **D** π rad

Apply to the formula $(x/\lambda) \times 2\pi$.

Answer: D

19 A point source emits 50.0 W of sound energy in all directions. A small microphone of area 0.85 cm^2 detects the sound at 4.0 m from the source.

What is the power received by the microphone?

A 1.6×10^{-5} W

B 2.1×10^{-5} W

C 2.1×10^{-1} W

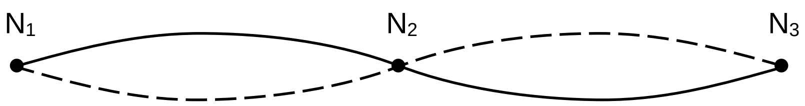
D 2.5×10^{-1} W

Intensity = power emitted /area spread = $50 / 4\pi r^2$

Power received = intensity × microphone area = 2.1×10^{-5} W

Answer: B

20 The diagram shows a standing wave on a string. The standing wave has three nodes N_1, N_2 and N_3.



Which statement is correct?

A All points on the string vibrate in phase.

B All points on the string vibrate with the same amplitude.

C Points equidistant from N_2 vibrate with the same frequency and in phase.

D Points equidistant from N_2 vibrate with the same frequency and the same amplitude.

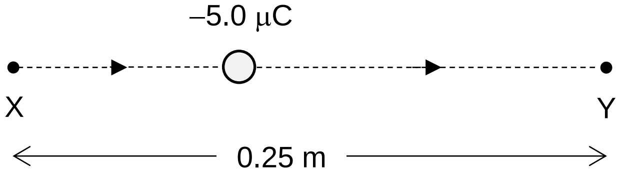
Ans: D

All points between N_1 and N_2 vibrate in phase, and are all in antiphase with points between N_2 and N_3.

All points between a node and an anti-node vibrate with different amplitudes

All points vibrate with same frequency. Points to the left of a node vibrate in antiphase with the points to the right of a node.

21 A particle of charge –5.0 μC is projected from X towards Y with kinetic energy 250 μJ. When the partice is at Y which is 0.25 m away from X, its kinetic energy decreased to 150 μJ.



Which of the following statements may not be correct?

A X is at a higher electric potential than Y.

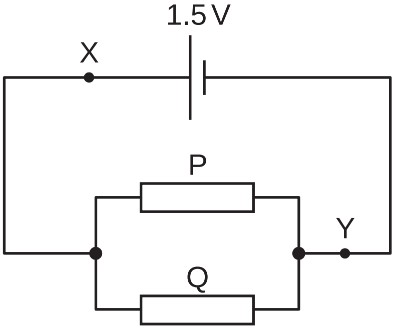
B The potential difference between X and Y is 20 V.

C The electric field between X and Y is of uniform strength 80 N m^{-1}.

D The electric field between X and Y is directed towards Y.

Ans: C
The field between X and Y need not be uniform. (C)
Since particle lost KE, it gained EPE + particle is negatively charged
→ X is at a higher potential than Y (A)
$\Delta V = \Delta W / q = (250 – 150) / 5.0 = 20$ V (B)
→ Field is directed from X to Y (D)

22 The diagram shows an electrical circuit consisting of a 1.5 V cell of negligible internal resistance and two resistors P and Q.



Which statement about this circuit is correct?

A The cell converts 1.5 J of electrical energy to chemical energy for each coulomb of charge passing through it.

B The energy dissipated per unit charge passing through P and Q is the same.

C The potential difference across P and the potential difference across Q add up to 1.5 V.

D The rate of flow of charge at point X is greater than the rate of flow of charge at Y.

Answer: B

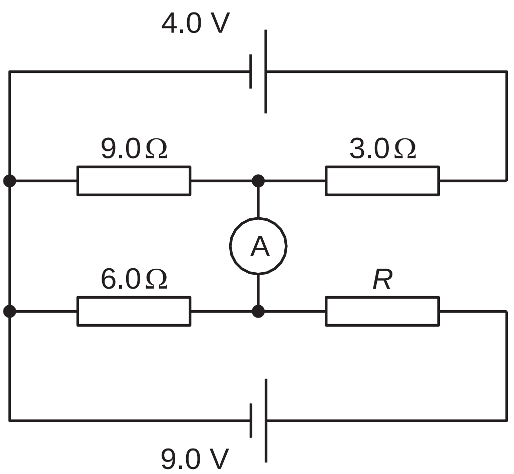
Option A is incorrect because the energy conversion inside the cell is from chemical energy to electrical energy, and not the other way around.

Option B is correct because P and Q are connected in parallel, thus they have the same potential difference across them. By definition, the work done converting electrical energy to thermal energy per unit charge in each resistor is the same as well.

Option C is incorrect because P and Q are connected in parallel, thus they have the same potential difference across them, which is 1.5 V across each resistor.

Option D is incorrect, because the rate of flow of charge (current) at X is the same as that at Y.

23 In the circuit shown, the cells have negligible internal resistance and the reading on the ammeter is zero.



What is the resistance of *R* ?

A 2.0 Ω **B** 6.0 Ω **C** 12 Ω **D** 18 Ω

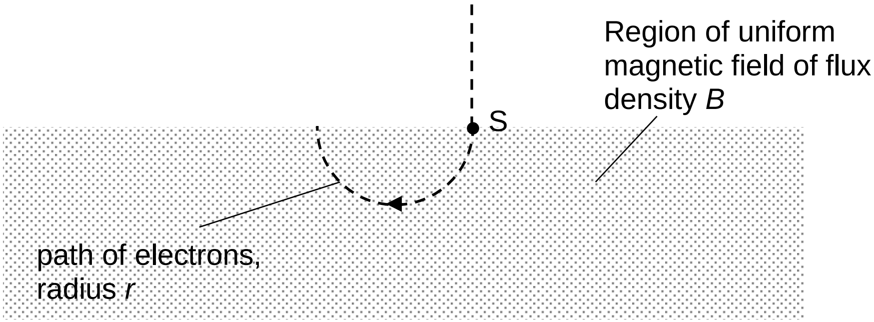
Answer: C
The ammeter reads zero which means the potentials at the two ends of the ammeter are the same. This means that the potential difference across the 9.0 Ω resistor is the same as that across the 6.0 Ω resistor.

$$\frac{V_{9.0\Omega}}{4.0} = \frac{9.0}{9.0+3.0}$$
$$V_{9.0\Omega} = 3.0 \text{ V}$$

$$\frac{V_{6.0\Omega}}{9.0} = \frac{6.0}{6.0+R}$$
$$\frac{3.0}{9.0} = \frac{6.0}{6.0+R}$$
$$V_{9.0\Omega} = 3.0 \text{ V}$$
$$R = 12\ \Omega$$

24 Electrons, each of mass m and charge q, are accelerated from rest in a vacuum through a potential difference V.

The accelerated electrons are then projected at point S into a region of uniform magnetic field of flux density B, as shown. The electrons move in a circular path of radius r.



Which of the following expressions represents the specific charge $\frac{q}{m}$ of the electrons?

A $\frac{V}{2B^2r}$ **B** $\frac{2V}{B^2r}$ **C** $\frac{V}{2B^2r^2}$ **D** $\frac{2V}{B^2r^2}$

Ans: D

$$qV=\frac{1}{2}mv^2$$

$$v=\sqrt{\frac{2qV}{m}}$$

$$Bqv=\frac{mv^2}{r}$$

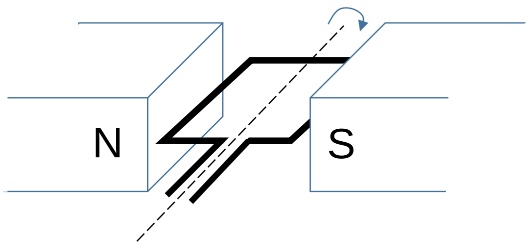
$$Bq\sqrt{\frac{2qV}{m}}=\frac{m\left(\frac{2qV}{m}\right)}{r}$$

$$\sqrt{\frac{2qV}{m}}=\frac{m\left(\frac{2V}{m}\right)}{Br}=\frac{2V}{Br}$$

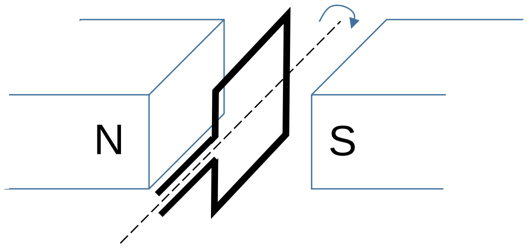
$$\frac{2qV}{m}=\frac{4V^2}{B^2r^2}$$

$$\frac{q}{m}=\frac{2V}{B^2r^2}$$

25 A rectangular coil made of 100 turns of wire with cross sectional area 30 cm^2 is placed within a uniform magnetic field of 0.80 T. The coil is rotated with an angular velocity of 100 rad s^{-1}. At different stages of its rotation, the cross sectional area of the coil can be parallel or perpendicular to the magnetic field, as shown.



parallel to magnetic field



perpendicular to magnetic field

What is the maximum e.m.f. induced and the corresponding orientation of the coil?

	maximum e.m.f. / V	orientation of coil
A	0.24	parallel to magnetic field
B	0.24	perpendicular to magnetic field
C	24	parallel to magnetic field
D	24	perpendicular to magnetic field

Ans: C

$$\phi = NBA\sin\omega t$$

$$\varepsilon = \frac{d\phi}{dt} = \omega NBA\cos\omega t$$

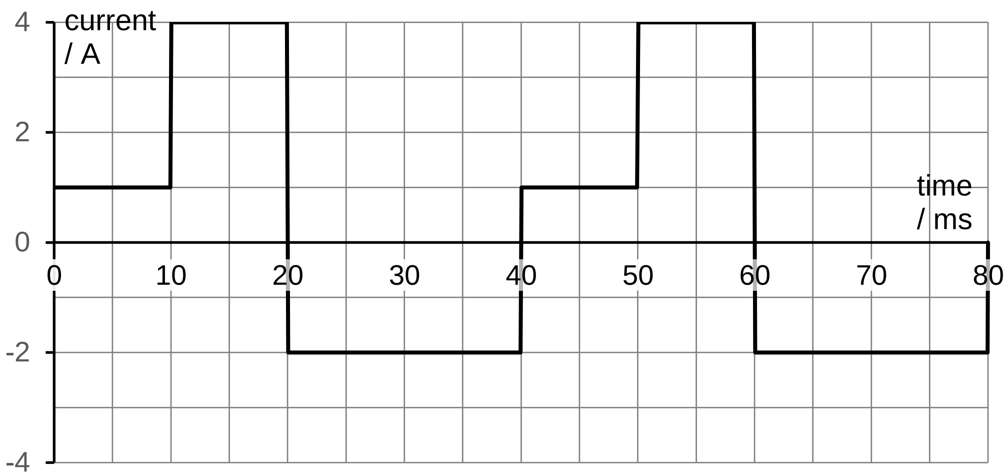
$$\varepsilon_{max} = \omega NBA = (100)(100)(0.80)(30\times(10^{-2})^2)$$

$$= 24\text{ V}$$

Maximum rate of change of flux linkage occurs when ϕ=0. I.e. at the instant of rotation where the coil is parallel to the magnetic field.

Distractors: forget to multiply by ω.

26 The graph below shows how the current in a coil varies with time.



What is the value of a steady current that will dissipate heat in the coil at the same average rate as the current above?

A 1.5 A **B** 2.3 A **C** 2.5 A **D** 2.6 A

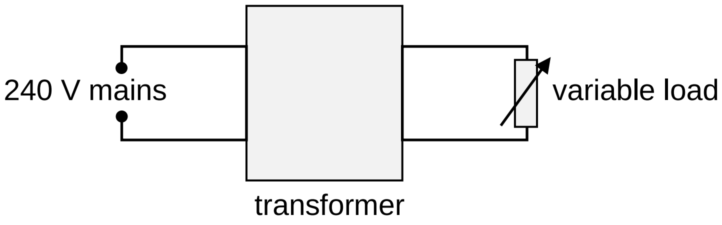
Ans: C

Area under current^2 graph = $(2\times1^2 + 2\times4^2 + 4\times2^2) \times 5 = 250$

Mean current^2 = 380 / 40 = 6.25 A^2

RMS current = $\sqrt{6.25}$ = 2.5 A

27 An ideal transformer steps down the 240 V sinusoidal voltage from the mains to 12 V, which is then applied to a variable load.



What is the change in the current supplied by the mains when the resistance of the load is increased from 20 Ω to 50 Ω?

A Decrease from 30 mA to 12 mA.

B Increase from 12 mA to 30 mA.

C Decrease from 12 mA to 4.8 mA.

D Increase from 0.24 A to 0.60 A.

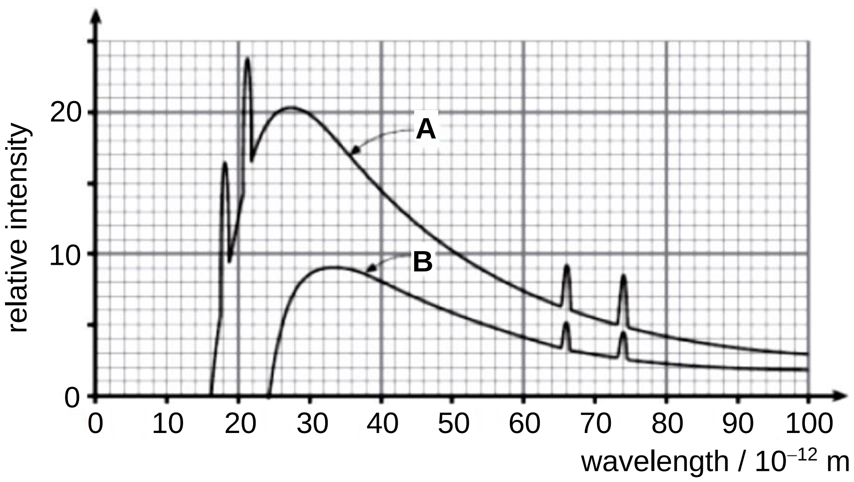
Ans: A

$I_P / I_S = n_S / n_P = V_S / V_P = 12 / 240 = 0.050$

At 20 Ω, $I_S = 12 / 20 = 0.60$ A → $I_P = 0.60 \times 0.050 = 0.030$ A

At 50 Ω, $I_S = 12 / 50 = 0.24$ A → $I_P = 0.24 \times 0.050 = 0.012$ A

28 The diagram shows two spectra of X-rays from an X-ray tube.



Which of the following statements is true?

A The accelerating potential to produce spectrum B is lower than that to produce spectrum A.

B A different target metal is used to produce spectra A and B as shown from the existence of additional peaks in spectrum A.

C With the same accelerating potential, the temperature of cathode used to produce spectrum A is higher than that to produce spectrum B as shown from the higher intensity of X-ray photons in spectrum A.

D The temperature of cathode used to produce spectrum A is higher than that to produce spectrum B as shown from the existence of additional peaks in spectrum A.

Ans: A

A: Lower accelerating p.d. for B, smaller loss in EPE and smaller gain in KE, smaller E of most energetic X-ray photon produced, larger cut-off wavelength. At the same time, fewer X-ray photons produced, hence intensity is lowered.

B: Additional peaks are observed in A because the cut-off wavelength for A is shorter. Same target metal used.

C: Higher temperature of cathode leads to more X-ray photons produced, hence intensity is higher. But it does not explain why the cut-off wavelength for A is shorter.

D: Higher temperature of cathode leads to more X-ray photons produced, hence intensity is higher. But it does not explain why additional peaks for A are observed.

29 Which of the following radioactive samples has the greatest activity?

	nuclide	amount / mole	half-life / day
A	$^{225}_{89}Ac$	0.003	10
B	$^{228}_{90}Th$	0.1	400
C	$^{228}_{88}Ra$	0.6	2100
D	$^{241}_{94}Pu$	1.0	4800

Answer: A

$A = \lambda N = \frac{\ln 2}{T_{1/2}} N$ where N is the number of molecules in the sample

So $N = n N_A$

And the A of each can be compared by finding the nuclide with the greatest ratio of $\frac{n}{T_{1/2}}$

Option A: $\frac{n}{T_{1/2}} = \frac{0.003}{10} = 0.0003$

Option B: $\frac{n}{T_{1/2}} = \frac{0.1}{400} = 0.00025$

Option C: $\frac{n}{T_{\frac{1}{2}}} = \frac{0.6}{2100} = 0.00029$

Option D: $\frac{n}{T_{\frac{1}{2}}} = \frac{1.0}{4800} = 0.00020$

30 A radioactive source is placed 1 cm from a Geiger-Muller tube, and various absorbers are placed between them, one at a time. For each absorber, a one-minute count is taken of the total number of decays, and this is repeated several times. The table shows the results of the experiment.

absorber	average number of decays detected in one minute
none	1043
0.1 mm paper	1040
1 mm aluminium	497
1 cm lead	6

The average background count per minute is 5.

What nuclear radiation do the results suggest the source was emitting?

A alpha and beta only

B beta only

C beta and gamma only

D alpha, beta and gamma

Answer: B

Type of decay	**alpha**	**beta**	**gamma**
Penetration power	3 cm of air A sheet of paper	3 m of air A sheet of aluminum of a few mm thickness	Lead, concrete or steel of >10 cm thickness

Because most particles can pass through paper, they are not alpha particles.
Some of them are absorbed by the aluminium, and stopped by 4 cm lead; they must be beta particles.

End of Paper