Class

Adm No

Candidate Name: ____________________

millennia institute

2023 Preliminary Examinations
Pre-University 3

H2 PHYSICS **9749/1**

Paper 1 Multiple Choice **21 September**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Do not turn over this page until you are told to do so.

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

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 OMR 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 working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

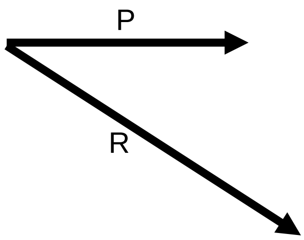
Data

speed of light in free space	c	=	$3.00 \cdot 10^{8}$ m s^{-1}
permeability of free space	μ_0	=	$4\pi \cdot 10^{-7}$ H m^{-1}
permittivity of free space	ε_0	=	$8.85 \cdot 10^{-12}$ F m^{-1}
		=	$(1/(36\pi)) \cdot 10^{-9}$ F m^{-1}
elementary charge	e	=	$1.60 \cdot 10^{-19}$ C
the Planck constant	h	=	$6.63 \cdot 10^{-34}$ J s
unified atomic mass constant	u	=	$1.66 \cdot 10^{-27}$ kg
rest mass of electron	m_e	=	$9.11 \cdot 10^{-31}$ kg
rest mass of proton	m_p	=	$1.67 \cdot 10^{-27}$ kg
molar gas constant	R	=	8.31 J K^{-1}mol^{-1}
the Avogadro constant	N_A	=	$6.02 \cdot 10^{23}$mol^{-1}
the Boltzmann constant	k	=	$1.38 \cdot 10^{-23}$ J K^{-1}
gravitational constant	G	=	$6.67 \cdot 10^{-11}$ N m^{2} kg^{-2}
acceleration of free fall	g	=	9.81 m s^{-2}

Formulae

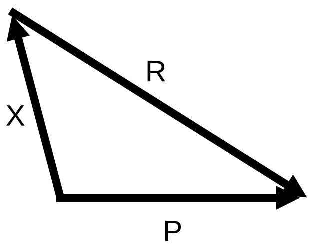
uniformly accelerated motion	s =	$ut + \frac{1}{2}at^2$
	v^2 =	$u^2 + 2as$
work done on/by a gas	W =	$p\Delta V$
hydrostatic pressure	p =	$\rho g h$
gravitational potential	φ =	$-\frac{Gm}{r}$
temperature	T/K =	$T/°C + 273.15$
pressure of an ideal gas	p =	$\frac{1}{3}\frac{Nm}{V}<c^2>$
mean kinetic energy of a molecule of an ideal gas	E =	$\frac{3}{2}kT$
displacement of particle in s.h.m.	x =	$x_o \sin \omega t$
velocity of particle in s.h.m.	v =	$v_o \cos \omega t$
	v =	$\pm\omega\sqrt{(x_o^2 - x^2)}$
electric current	I =	$Anvq$
resistors in series	R =	$R_1 + R_2 + \ldots$
resistors in parallel	$\frac{1}{R}$ =	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots$
electric potential	V =	$\frac{Q}{4\pi\varepsilon_0 r}$
alternating current/voltage	x =	$x_o \sin \omega t$
magnetic flux density due to a long straight wire	B =	$\frac{\mu_o I}{2\pi d}$
magnetic flux density due to a flat circular coil	B =	$\frac{\mu_o NI}{2r}$
magnetic flux density due to a long solenoid	B =	$\mu_o nI$
radioactive decay	x =	$x_0 \exp(-\lambda t)$
decay constant,	λ =	$\frac{ln2}{t_{1/2}}$

1 P and R are coplanar vectors.

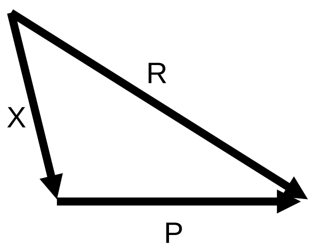


If X = P – R, which diagram best represents vector X?

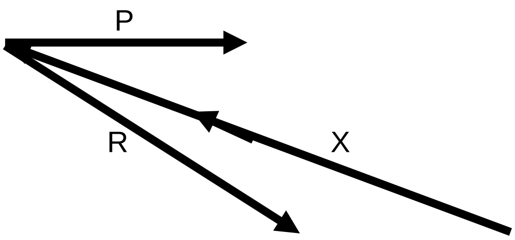
A



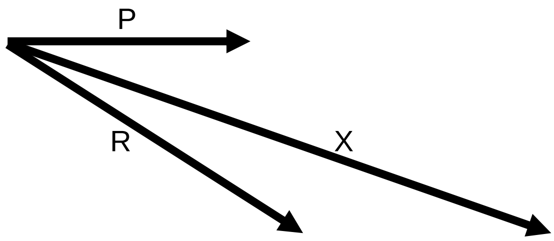
B



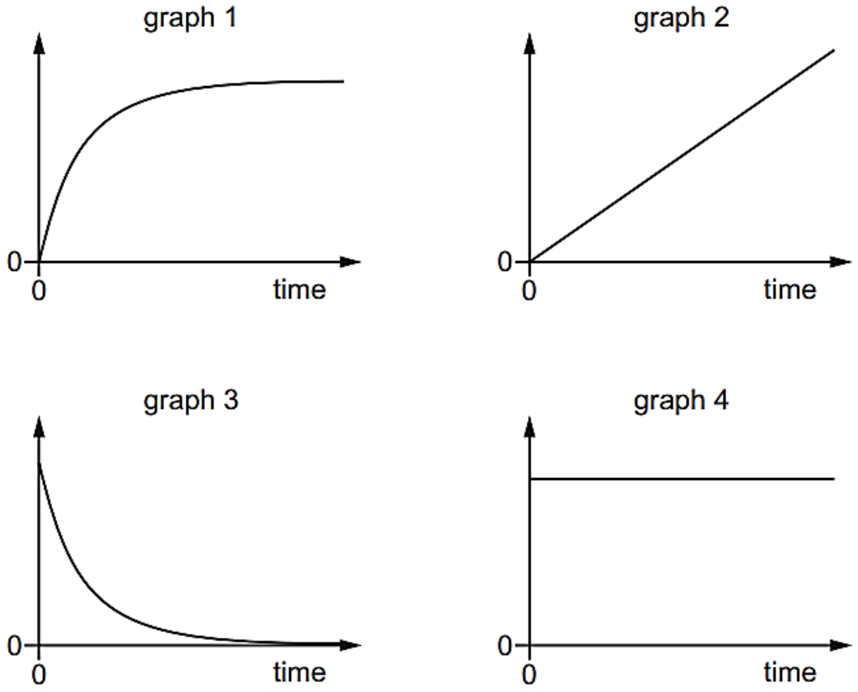
C



D



2 The following are graphs of various quantities plotted against time for an object dropped from a stationary balloon high in the atmosphere.



Which of the following statements most accurately describes the graphs?

A Graph 1 is acceleration against time and graph 3 is resultant force against time.

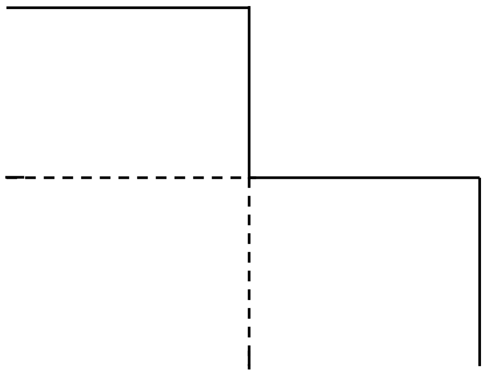
B Graph 1 is acceleration against time and graph 4 is resultant force against time.

C Graph 3 is acceleration against time and graph 1 is velocity against time.

D Graph 3 is acceleration against time and graph 2 is velocity against time.

3 The force acting on a 3.0 kg mass varies with time as shown.

The object is initially moving at a velocity of 0.50 m s^{-1} in the same direction as the force.

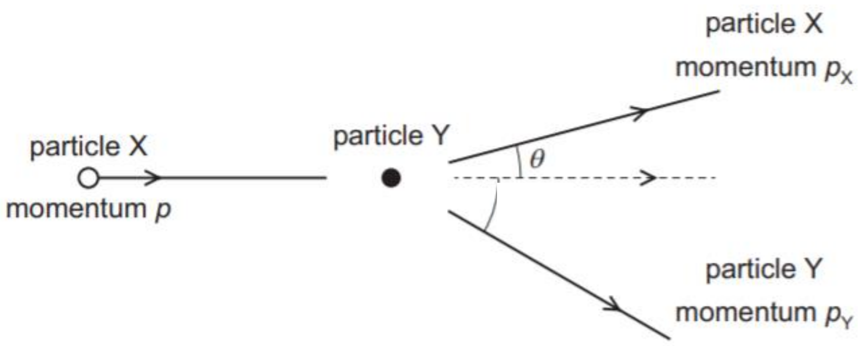


time / s
force / N
0 0.5 1.0
10
5
0

What is the speed of the mass after 1.0 s?

A 2.5 m s^{-1} **B** 3.0 m s^{-1} **C** 5.0 m s^{-1} **D** 7.5 m s^{-1}

4 A particle X has initial momentum p. It collides with a stationary particle Y. The particle X is deflected through angle θ and its momentum is p_X. The particle Y moves off at angle α to the original direction of motion of particle X with momentum p_Y as shown.



Which equation is a correct statement for momentum in this collision?

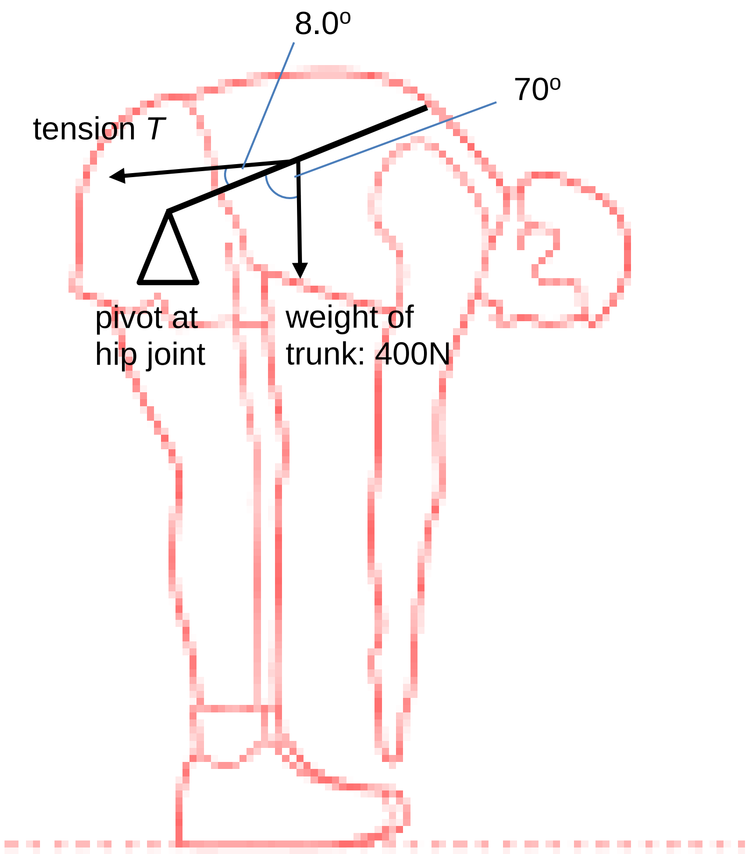
A $p_X \cos\theta = p_Y \cos\alpha$

B $p_X \sin\theta = p_Y \sin\alpha$

C $p_X \cos\theta + p_Y \cos\alpha = 0$

D $p = p_X \sin\theta + p_Y \sin\alpha$

5 A simplified diagram below represents the trunk of a person bent forward, with the spine at an angle of 70° to the vertical. The back muscle exerts a tension T and makes an angle of 8.0° to the spine. The weight of the person's trunk which is 400 N, acts at the point along the spine where the back muscle is attached.



What is the tension *T* in the back muscle?

A 140 N **B** 380 N

C 980 N **D** 2700 N

6 When a pebble of volume $2.0 \times 10^{-4}\ m^3$ is hung on a spring balance, a reading of 8.0 N is obtained. The pebble is now totally immersed in a liquid of density $800\ kg\ m^{-3}$.

What is the reading on the spring balance now?

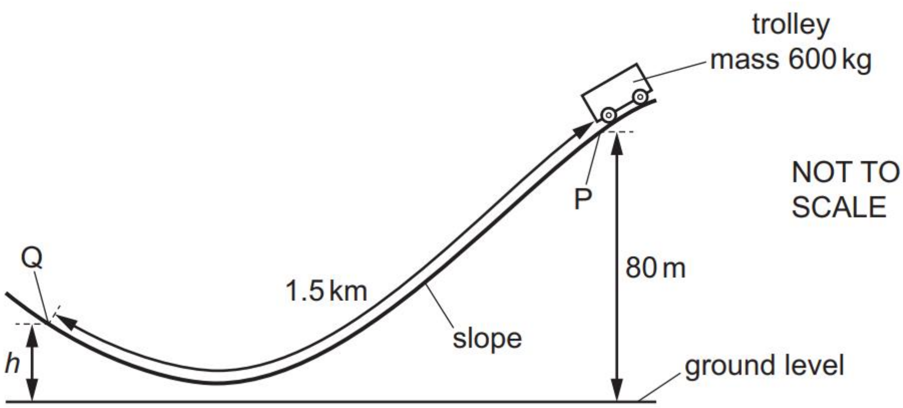
A 1.6 N

B 6.4 N

C 8.0 N

D 9.6 N

7 A trolley of mass 600 kg initially at point P on a slope, at height of 80 m above ground level, as shown. The trolley is released from rest and moves along the slope, reaches a speed of 12.0 m s^{-1} at point Q, at height *h* above the ground level.

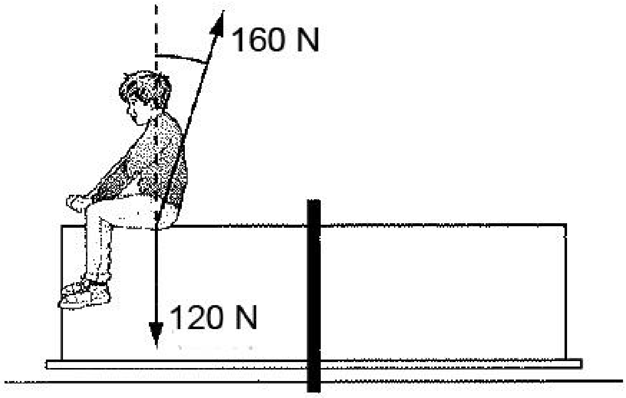


The total distance PQ moved by the trolley along the slope is 1.5 km. A constant resistive force of 200 N opposes the motion of the trolley on the slope.

What is the value of *h*?

A 3.5 m **B** 22 m **C** 29 m **D** 55 m

8 A boy is sitting on a playground turntable and is rotating with uniform angular velocity.



The reaction force that the turntable exerts on the child is 160 N.
The weight of the boy is 120 N.

What is the acceleration of the boy?

A 0.88 m s^{-2} **B** 3.3 m s^{-2} **C** 8.7 m s^{-2} **D** 84.3 m s^{-2}

9 A space probe is used to measure the gravitational field strength *g* of a planet at a distance *r* from its centre.

A graph of *g* against $\frac{1}{r^2}$ for this planet produces a straight line graph through the origin.

Which quantity can be determined from the gradient of the straight line graph?

A the density of the planet

B the radius of the planet

C the volume of the planet

D the mass of the planet

10 A satellite is in geostationary orbit above the Earth at a height of 36 000 km. The radius of the Earth is 6400 km.

What is the orbital speed of the satellite?

A 490 m s^{-1}

B 2200 m s^{-1}

C 2600 m s^{-1}

D 3100 m s^{-1}

11 A fixed mass of an ideal gas is at a pressure of 1.0 x 10^5 Pa. It has a temperature of 300 K and a volume of 0.010 m^3.

What is the total kinetic energy of the gas molecules after the volume is changed to 0.0050 m^3 at constant temperature?

A 500 J

B 1000 J

C 1500 J

D 2000 J

12 The r.m.s. speed of the molecules of a gas at 295 K is decreased by 20 %.

What is the new temperature of the gas?

A – 84.4 °C

B – 37.2 °C

C 189 °C

D 236 °C

13 75 g of potato chips is used as fuel to heat up a calorimeter that contains 2.00 x 10^3 g of water initially at 297 K. The temperature rises by 12 °C. The heat capacity of the calorimeter is 200 J K ^{1} and the specific heat capacity of water is 4.18 J g ^{1} K ^{1}.

How much heat is released per gram of potato chip?

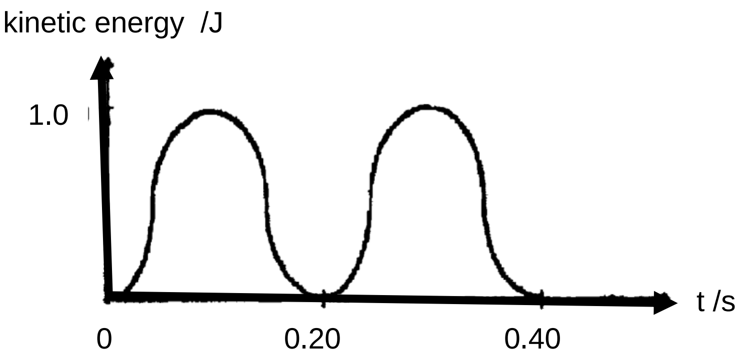
A 1.37 kJ g^{-1}

B 7.10 kJ g^{-1}

C 100 kJ g^{-1}

D 103 kJ g^{-1}

14 The graph shows the variation of the kinetic energy with time of a particle undergoing simple harmonic motion with an amplitude of 0.30 cm.



What is the maximum acceleration of the particle in m s^{-2}?

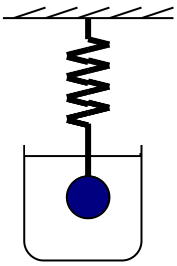
A 0.094

B 0.74

C 1.8

D 3.0

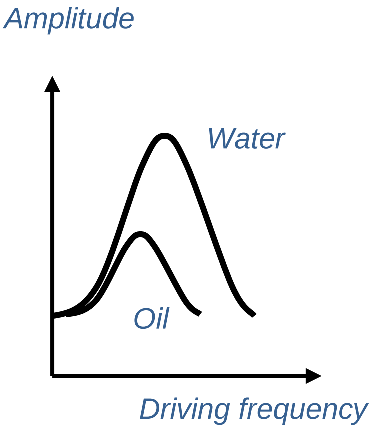
15 A mass oscillates vertically in water as shown. The support vibrates with a driving frequency which can be varied. Another similar setup is used replacing water with oil.



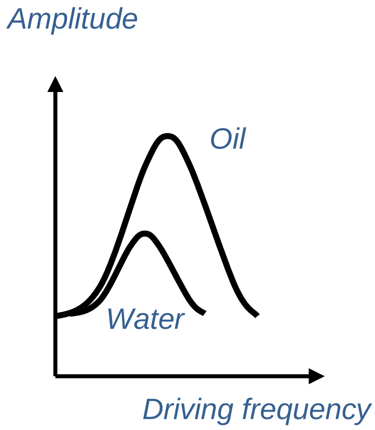
Given that oil has higher viscosity than water, which graph best represents the way in which the amplitudes of both cases vary with driving frequency?

[13A]

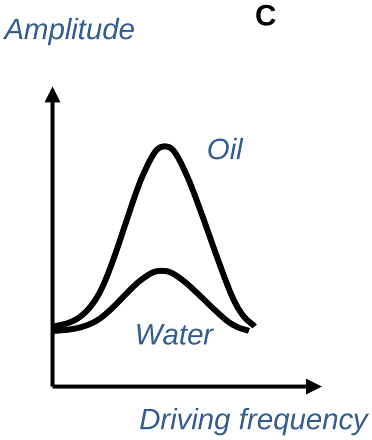
A



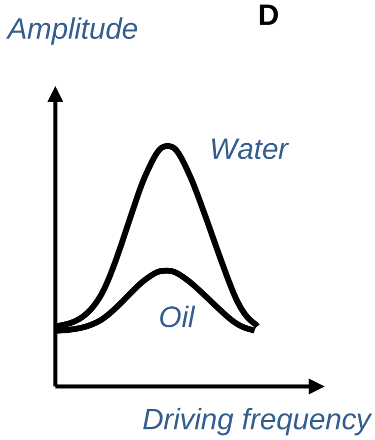
B



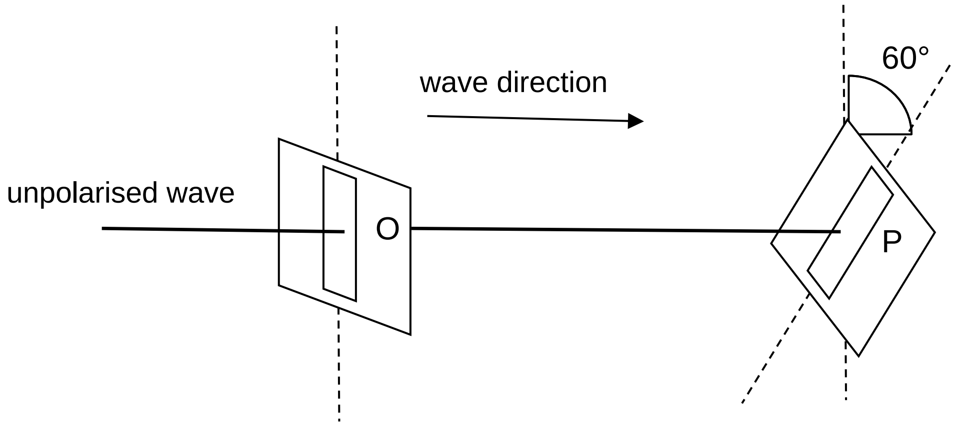
C



D



16 An unpolarised wave passes through polariser O such that the emerging wave is plane-polarized with an intensity of 2.0 W m^{-2}. A second polariser P is placed further such that the plane-polarised wave is incident normally on it. Polariser P is rotated clockwise by an angle of 60°.



What is the intensity of the wave after passing through polariser P ?

A 0.25 W m^{-2}

B 0.5 W m^{-2}

C 1.0 W m^{-2}

D 2.0 W m^{-2}

17 In order to demonstrate stationary waves, a student holds a tuning fork above a vertical glass tube containing some water and some air.

Which processes are responsible for the formation of the stationary wave?

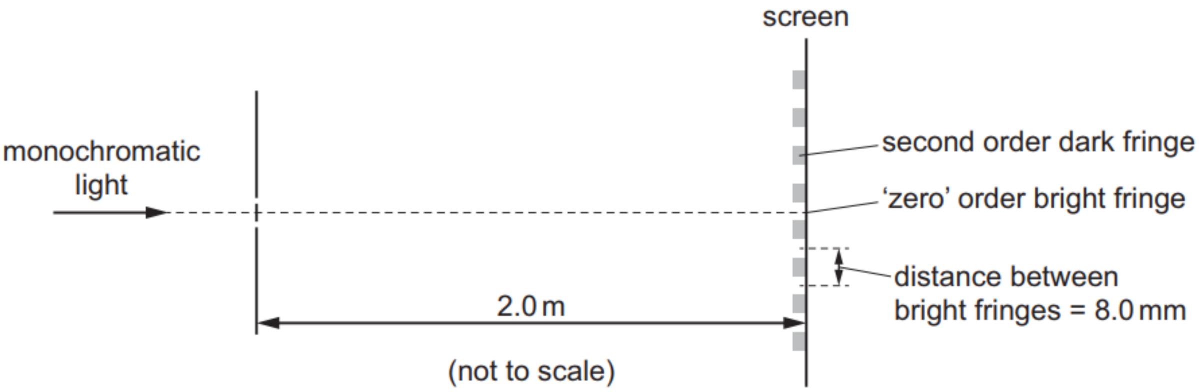
A diffraction and polarization

B interference and diffraction

C polarisation and reflection

D reflection and interference

18 Monochromatic light is incident on a pair of narrow slits a distance of 0.10 mm apart. A series of bright and dark fringes are observed on a screen a distance of 2.0 m away. The distance between adjacent bright fringes is 8.0 mm.



What is the path difference between the light waves from the two slits that meet at the second order **dark** fringe?

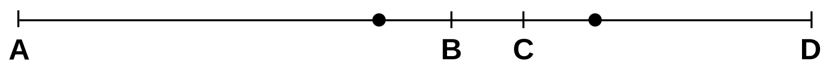
A $2.0 \cdot 10^{-7}$ m

B $4.0 \cdot 10^{-7}$ m

C $6.0 \cdot 10^{-7}$ m

D $8.0 \cdot 10^{-7}$ m

19 Two point charges $+4Q$ and $-Q$ are situated as shown.



At which point could the resultant electric field due to these charges be zero?

20 A positive charge of $2.6 \cdot 10^{-8}$ C is in a uniform electric field of field strength $3.0 \cdot 10^{5}$ N C^{-1}.

How much work must be done on the charge in order to slowly move it a distance of 4.0 mm in the opposite direction to the direction of the field?

A $3.1 \cdot 10^{-2}$ J

B $3.1 \cdot 10^{-5}$ J

C $3.1 \cdot 10^{-5}$ J **D** $3.1 \cdot 10^{-2}$ J

21 A filament lamp is rated as “120V, 40W”.

The lamp is connected into a circuit so that it lights up normally.

Which statement is correct?

A The charge passing through the filament in one second is 3.0 C.

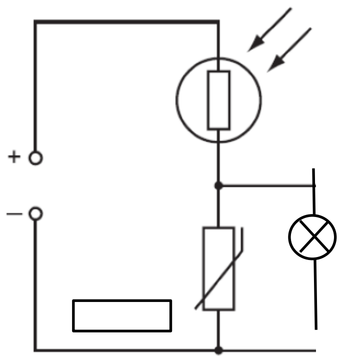
B The lamp transfer 40 J for each coulomb passing through the filament.

C The lamp transfers 120 J in 3.0 s.

D The supply provides 40 J to the lamp when the current is 3 A.

22 A filament lamp is connected into an electrical circuit with a negative temperature coefficient (NTC) thermistor and a light-dependent resistor (LDR).

Which pair of changes must cause the filament lamp to glow more brightly?

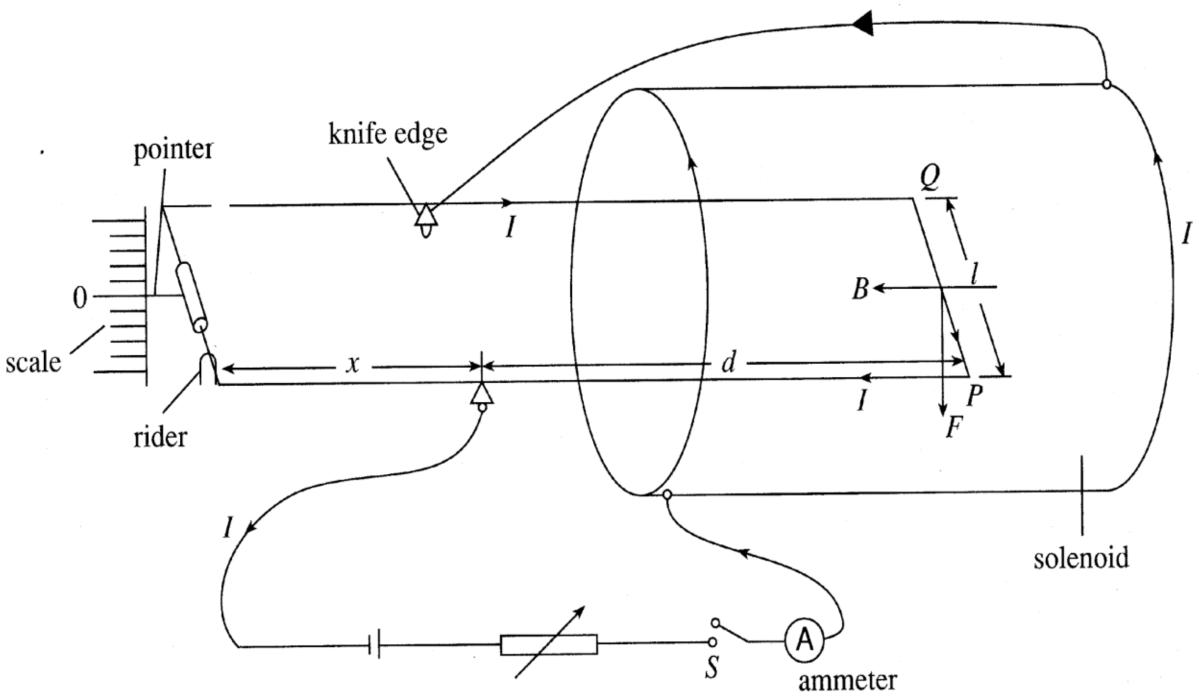


	light intensity incident on LDR	thermistor temperature
A	increase	decrease
B	increase	increase
C	decrease	decrease
D	decrease	increase

23 Two very long, straight, parallel wires carry equal steady current I in opposite directions. The distance between the wires is d. At a certain instant of time, a point charge q is at a point equidistant from the two wires, in the plane of the wires. Its instantaneous velocity v is perpendicular to this plane. What is the magnitude of the force due to the magnetic field acting on the charge at this instant?

A 0 N **B** $\dfrac{\mu_0 I q v}{2\pi d}$ **C** $\dfrac{\mu_0 I q v}{\pi d}$ **D** $\dfrac{2\mu_0 I q v}{\pi d}$

24 A current balance device as shown in the figure below was set up to determine the magnetic field strength created by a solenoid. The first experiment determined the magnetic field strength as B. The setup was used again with one or some of the factors changed. A larger mass of the rider had to be used in the second experiment.



Which one of the following could most likely be the changes made?

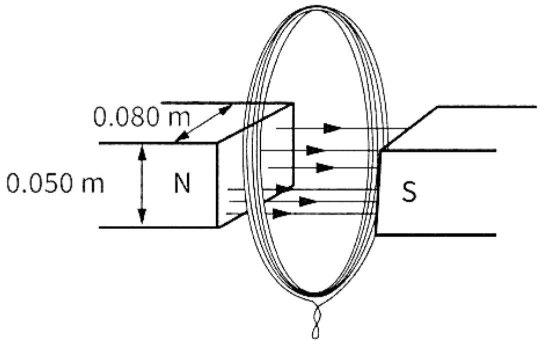
A The knife edge was moved closer to PQ.

B Another frame with a shorter length for PQ was used.

C The current passing through the solenoid and the number of turns of the solenoid are reduced.

D The first experiment was set up such that the direction of the Earth's magnetic field is opposite to the magnetic field created by the coil while the second experiment had both magnetic fields in the same direction.

25 An electromagnet produces a uniform field from left to right in the gap between its poles. The gap has sides 0.050 m × 0.080 m and there is no field outside the gap. A circular coil of radius 0.100 m, has 40 turns and it surrounds all of the magnetic flux as shown below.



The ends of the coil are connected together so that an induced e.m.f. in the coil produces a current in the coil.

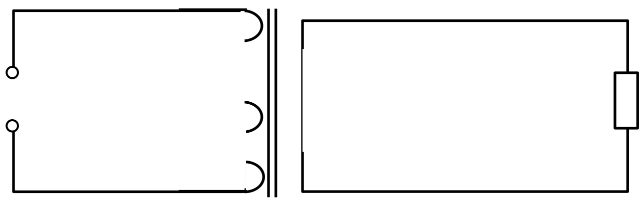
The magnetic flux density of the electromagnet fall linearly from 0.15 T to zero in a time of 3.0 s.

What is the average induced e.m.f. in the coil as the magnetic flux density decreases?

A 0.20 mV **B** 8.0 mV

C 50 mV **D** 63 mV

26 The primary coil of an ideal transformer has 1000 turns and is connected to an A.C. supply. The secondary coil has 40 turns and is connected to a load which has a power rating of 12 W.



1000 turns
40 turns

Load
12 W

A.C. supply

If the root-mean-square (r.m.s) voltage across the load is 6.5 V, what is the r.m.s current in the primary coil?

A 0.026 A

B 0.074 A

C 0.10 A

D 0.15 A

27 The following are some statements on photoelectric effect. Which of the following statements is true?

A No emission of electrons occurs for very low intensity of illumination.

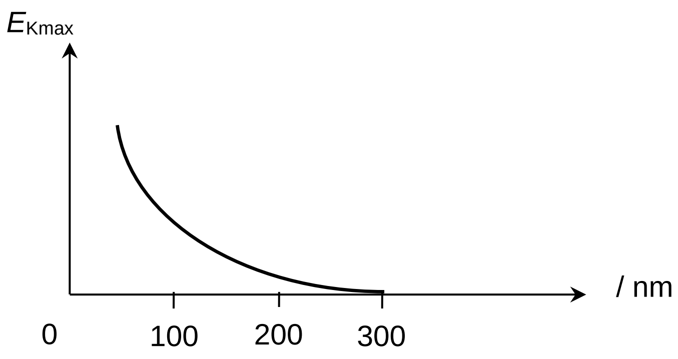
B Doubling the frequency of radiation will double the stopping potential.

C For a given metal, there is a minimum frequency of radiation below which no emission of photoelectrons occurs.

D The velocity of the emitted photoelectrons will increase if the intensity of the incident radiation increases on the metal surface.

28 In a photoelectric experiment, the maximum kinetic energy of the ejected photoelectrons is measured for various wavelength of incident electromagnetic radiation.

A graph of this maximum kinetic energy, E_{Kmax}, against the wavelength λ of the incident electromagnetic radiation falling on the surface of a metal is shown below.



What is the work function for this metal?

A 2.07 eV **B** 4.14 eV **C** 6.63 eV **D** 7.96 eV

29 Consider the following nuclear reaction:

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{121}_{45}Rh + ^{113}_{47}Ag + 2^{1}_{0}n$$

Data:

binding energy per nucleon of $^{235}_{92}U$ = 7.59 MeV

binding energy per nucleon of $^{121}_{45}Rh$ = 8.26 MeV

binding energy per nucleon of $^{113}_{47}Ag$ = 8.52 MeV

What is the energy change in this reaction?

A 73.9 MeV of energy is absorbed.

B 73.9 MeV of energy is released.

C 179 MeV of energy is absorbed.

D 179 MeV of energy is released.

30 A radioactive sample of element X has an activity of *A*.

Another radioactive sample of element Y with the same number of radioactive nuclei as the sample of X has an activity of 3*A*.

What is the ratio $\frac{\text{half life of X}}{\text{half life of Y}}$?

A 0.11 **B** 0.33 **C** 3.0 **D** 9.0

End of Paper