2024 Preliminary Examination H2 Physics Paper 1 Suggested Solution

1	**D**	**6**	**B**	**11**	**A**	**16**	**B**	**21**	**A**	**26**	**A**
2	**C**	**7**	**D**	**12**	**C**	**17**	**D**	**22**	**B**	**27**	**A**
3	**C**	**8**	**D**	**13**	**A**	**18**	**B**	**23**	**A**	**28**	**D**
4	**D**	**9**	**C**	**14**	**D**	**19**	**D**	**24**	**B**	**29**	**A**
5	**A**	**10**	**C**	**15**	**A**	**20**	**B**	**25**	**B**	**30**	**C**

1. Which one of the following estimates is unrealistic?

A The potential energy of a man at the top of Bukit Timah Hill is 100 kJ.
B The volume of air in a classroom is 150 m^3.
C The mass of an apple is 100 g
D The average temperature of fire is 300 K.

Ans: D

A: Height of Bukit Timah Hill = 160 m,
potential energy of man = mgh = (60)(9.81)(160)
= 94 kJ

B: Volume of air in classroom = volume of classroom
= 7 x 8 x 3
= 147 m^3

C: 100 g for an apple is quite reasonable right…

D: 300 K is 27 °C, so is unrealistic for the temperature for fire.

2. The velocity- time graph of a particle moving in a straight line is shown in Fig. 2:

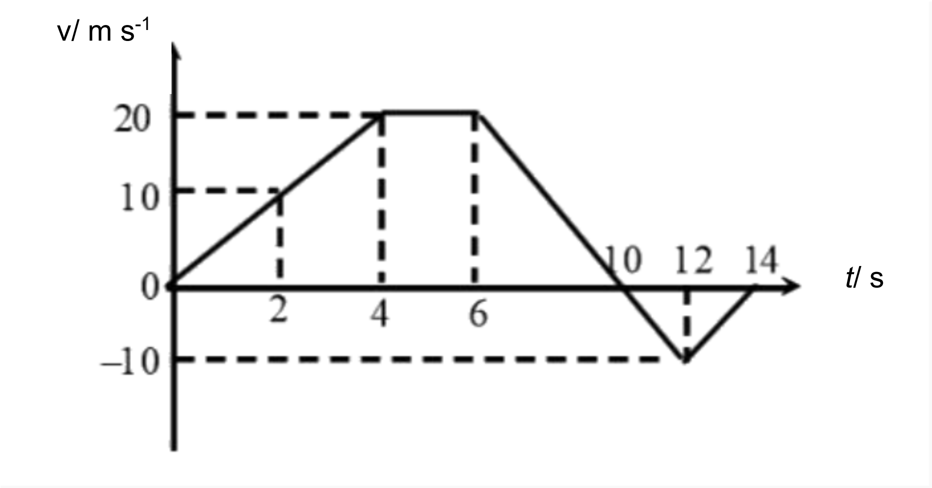


Fig. 2

What are the average speed and velocity of the particle between time t = 0 and t = 14 s?

	Average speed / m s^{-1}	Average velocity / m s^{-1}
A	7.1	7.1
B	7.1	10
C	10	7.1
D	10	10

Ans: C

Displacement = Area under velocity-time graph

$$= \frac{1}{2}(2+10)(20) - \frac{1}{2}(10)(4)$$

Above time axis: positive displacement
Below time axis: negative displacement

$$= 120 - 20$$
$$= 100 \text{ m}$$

$$\text{Average velocity} = \frac{\text{displacement}}{\text{time}} = \frac{100}{14}$$
$$= 7.1 \text{ m s}^{-1}$$

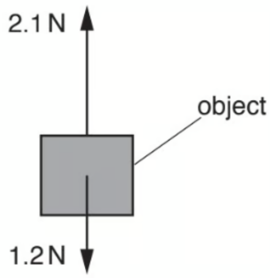
Distance = Area under velocity-time graph

Distance is a scalar and has no direction. So areas above and below time axis are considered as positive.

$$= \frac{1}{2}(2+10)(20) + \frac{1}{2}(10)(4)$$
$$= 120 + 20$$
$$= 140 \text{ m}$$

$$\text{Average velocity} = \frac{\text{displacement}}{\text{time}} = \frac{140}{14}$$
$$= 10 \text{ m s}^{-1}$$

3. The diagram shows two opposite vertical forces of magnitude 1.2 N and 2.1 N acting on an object.



Which of the following statements is wrong?

A The magnitude of the resultant force is 0.9 N.
B The object is accelerating and moving up.
C The object is decelerating and moving up.
D The object is decelerating and moving down.

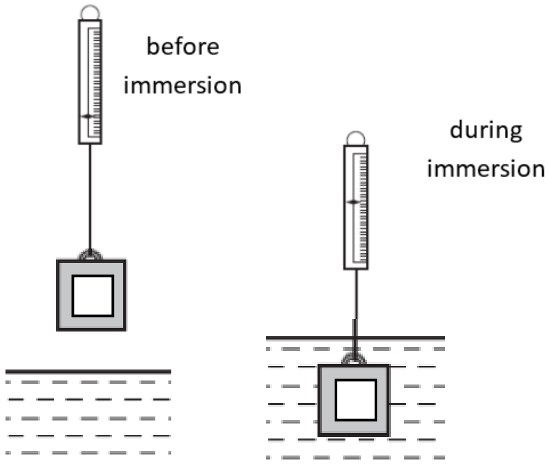
Ans: C

Option A: The magnitude of the resultant force is 2.1 – 1.2 = 0.9 N
Option B: The resultant force is 0.9 N upwards since the force exerted on it upwards is larger than the force exerted on it downwards. If object is moving upwards in the same direction of the resultant force, it will be accelerating.

Option C: If object is moving upwards in the same direction of the resultant force, it will be accelerating and not decelerating. So this is the wrong statement.

Option D: If object is moving downwards in the opposite direction of the resultant force, it will be decelerating.

4. The diagrams show a hollow metal cube, with a sealed opening, is suspended from a spring balance before and during immersion in water. A reduction in the balance reading occurs because of the immersion.



Water is then allowed to enter the metal cube, through the opening, to fill up the empty space in the cube.

Which of the following statements is correct?

A Upthrust of the water on the cube increases, hence the balance reading will be further reduced.

B The balance reading during immersion corresponds to the upthrust of the water on the cube.

C The balance reading stays the same as the increase in weight of water in the cube is offset by the increase in upthrust of the water on the cube.

D The balance reading increases due to the increase of gravitational pull on the cube.

Ans: D

Option A: Upthrust is equal to the weight of water displaced by the cube. There is no change to the volume of the cube, hence there is no change in the upthrust.

Option B: Tension + Upthrust = Weight

Tension = Weight – Upthrust

The balance reading due to tension does not correspond to the upthrust of water on the cube.

Option C: Upthrust does not change. As water fills up the empty space in the cube, the weight of the cube will increase. Hence, balance reading will not stay the same.

Option D: Same reasoning as option C, upthrust does not change but weight increases, hence balance reading increases due to the gravitational pull (weight) on the cube.

5. Which row in the table gives the gravitational potential energy, the elastic potential energy and the kinetic energy of a bungee jumper during the first fall? Air resistance is negligible.

		Gravitational potential energy/ kJ	Elastic potential energy/ kJ	Kinetic energy/kJ
A	top middle bottom	120 60 0	0 10 120	0 50 0
B	top middle bottom	120 60 0	0 30 60	0 30 60
C	top middle bottom	120 60 0	0 30 120	0 60 0
D	top middle bottom	120 60 0	0 60 120	0 0 0

Ans: A

At the top: There is only GPE. Hence, EPE and KE equal to 0.

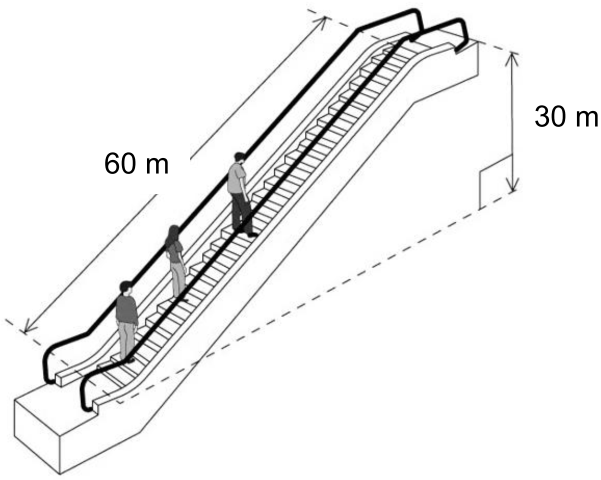
At the bottom: All GPE is lost and converted to EPE as it is momentarily at rest, hence KE = 0. Option B is wrong.

At the middle: GPE lost is converted to gain in EPE and KE. The bungee jumper is moving, so KE cannot be 0. Option D is wrong

The total energy stays constant at 120 kJ. Option C is wrong.

Only Option A gives the correct combinations of energy at the different positions.

6. An escalator is 60 m long and lifts passengers through a vertical height of 30 m, as shown.



To drive the escalator against the forces of friction when there are no passengers requires a power of 2.0 kW.

The escalator is used by passengers of average mass 60 kg and the power to overcome friction remains constant.

How much power is required to drive the escalator when it is carrying 20 passengers and is travelling at 0.75 m s^{-1}?

A 4.4 kW

B 6.4 kW

C 8.8 kW

D 10.8 kW

Ans: B

Power required to drive the escalator with 20 passengers

= power to drive the escalator when there are no passengers + power to drive 20 passengers of an average mass of 60 kg each

$$= P_{escalator} + Fv$$
$$= P_{escalator} + (mg\sin\theta)v$$
$$= 2.0 \times 10^3 + 20(60)(9.81)(\frac{30}{60})(0.75)$$

= 6414 = 6.4 kW

7. A turntable is rotating at a constant number of revolutions per second. What is the relationship between the angular velocity of a point on the turntable and the distance of the point from the centre of the turntable?

A Angular velocity is directly proportional to the distance.
B Angular velocity is inversely proportional to the distance.
C Angular velocity is directly proportional to the distance squared.
D Angular velocity is independent of distance.

Ans: D

Given number of revolutions per second, f = constant

$\therefore$ angular velocity $\omega = 2\pi f$ is a constant, independent of distance.

8. A satellite of mass M is in circular orbit with radius r around the Earth with a period of T. A second satellite of mass $2M$ moves around the Earth with radius $4r$. What is the period of this second satellite in terms of T?

A $\frac{T}{4}$

B $2T$

C $4T$

D $8T$

Ans: D

For the 1st satellite,

$$\frac{GM_E M}{r^2} = Mrw^2$$

$$\frac{GM_E M}{r^2} = Mr(\frac{2\pi}{T})^2$$

$$T = 2\pi\sqrt{\frac{r^3}{GM_E}}$$

For 2nd satellite, $T' = 2\pi\sqrt{\frac{(4r)^3}{GM_E}} = 8T$

9. What is the approximate number of atoms in a cubic metre of an ideal monatomic gas at the temperature of 27 °C and a pressure of 1 x 10^5 Pa?

A 1 x 10^{22} **B** 6 x 10^{23} **C** 2 x 10^{25} **D** 3 x 10^{26}

Ans: C

$$\begin{aligned} pV &= NkT \\ (1\times10^5)(1) &= N(1.38\times10^{-23})(27+273.15) \\ N &= 2.41\times10^{25} \\ &\approx 2\times10^{25} \end{aligned}$$

10. A fixed mass of monatomic ideal gas at a volume *V* at temperature *T* and pressure *P* has a root mean square speed *c*. After absorbing heat, its final volume is *V* and final pressure is 2*P.*

What is the new root mean square speed of the ideal gas?

A 0.5 *c* **B** 0.71 *c* **C** 1.4 *c* **D** 2.0 *c*

Ans: C

pV = *NkT*. Since volume *V* remains the same and pressure is doubled, it means that the final temperature is also doubled.

$$\begin{aligned} \text{Initial: } \frac{1}{2}m\langle c^2\rangle &= \frac{3}{2}kT \\ \text{Final: } \frac{1}{2}m\langle c_f^2\rangle &= \frac{3}{2}k(2T) \end{aligned}$$

$$\begin{aligned} \sqrt{\langle c_f^2\rangle} &= \sqrt{2}\sqrt{\langle c^2\rangle} \\ &= 1.4\sqrt{\langle c^2\rangle} \end{aligned}$$

11. An ideal gas is confined in a cylinder fitted with a frictionless piston. When 90 J of heat is supplied and the gas is allowed to expand 2.5×10^{-4} m^3 in volume at a constant pressure of 2.0×10^5 Pa, the temperature rises by 4.5 K.

What is the increase in internal energy during this process?

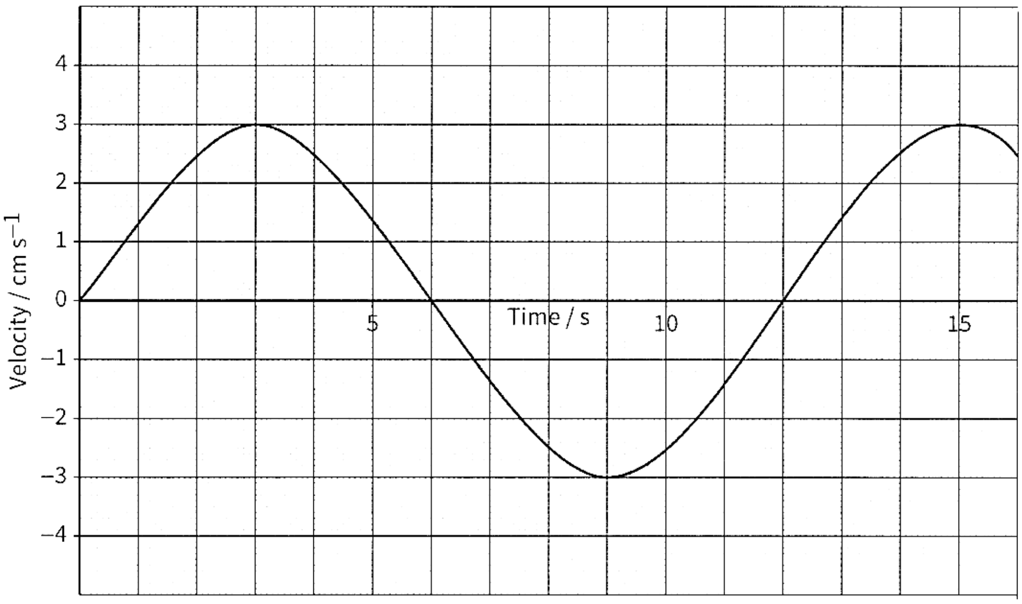
A 40 J **B** 50 J **C** 90 J **D** 140 J

Ans: A

Expanding under constant pressure:

$$\begin{aligned}
\Delta U &= Q + W_{on} \\
&= Q + (-p\Delta V) \\
&= 90 + (-2.0 \times 10^5 \times 2.5 \times 10^{-4}) \\
&= 90 - 50 \\
&= 40 \text{ J}
\end{aligned}$$

12. The graph below shows the variation with time of the velocity of a 5.0 kg oscillating mass.



What is the maximum restoring force acting on the mass as it oscillates?

A 0.041 N **B** 0.050 N **C** 0.079 N **D** 0.15 N

Ans: C

From the graph, period T = 12 s, so $\omega = \dfrac{2\pi}{T} = \dfrac{2\pi}{12}$.

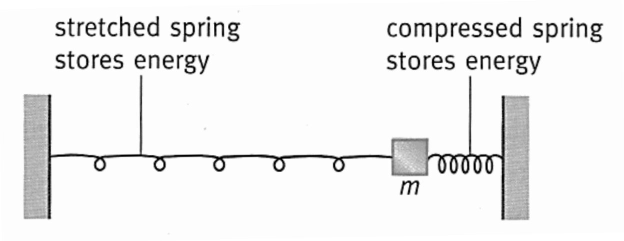
Also, $v_0 = 3$ cm s^{-1}

Using $v_0 = \omega x_0$, $3 = \dfrac{2\pi}{12} x_0$ giving $x_0 = 5.730$ cm

Using $|a_o| = \omega^2 x_o$, $a_o = \left(\dfrac{2\pi}{12}\right)^2 \times 5.730 = 1.571 \text{ cm s}^{-2} = 1.571 \times 10^{-2} \text{ m s}^{-2}$

Hence maximum restoring force = ma_o = 5.0 x 1.571×10^{-2} = 7.9×10^{-2} N

13. An object of mass m oscillates in simple harmonic motion between two springs as shown below. The amplitude of the motion is x_o.



What is the ratio $\dfrac{\text{elastic potential energy of the two springs}}{\text{kinetic energy of the object}}$ when the object is $\dfrac{x_o}{2}$ from its equilibrium?

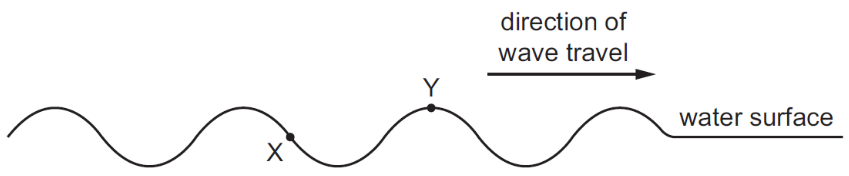
A $\frac{1}{3}$ **B** $\frac{1}{2}$ **C** 1 **D** 3

Ans: A

Let the total energy of the oscillating system be $E = \frac{1}{2}m\omega^2 x_0{}^2$.

Since potential energy of the system is $\frac{1}{2}m\omega^2 x^2$, when $x = \frac{1}{2}x_0$, the potential energy is $\frac{E}{4}$. Then the kinetic energy would have to be $\frac{3E}{4}$. Hence ratio is $\frac{1}{3}$.

14. X and Y are two points on the surface of water in a ripple tank. A source of constant frequency generates a wave which travels past X and Y, causing them to oscillate vertically.



What is the phase difference between X and Y?

A 45° **B** 135° **C** 180° **D** 270°

Ans: D
From the diagram, path difference between X and Y, $\Delta x = 0.75\lambda$

Therefore, phase difference, $\Delta\phi_{XY} = \dfrac{\Delta x}{\lambda} \times 360° = \dfrac{0.75\lambda}{\lambda} \times 360° = 270°$

15. A point source of sound emits energy equally in all directions at a constant rate and a detector placed 3.0 m form the source measures an intensity of 3.0 W m^{-2}.

What intensity would the detector measure if it is now placed at a distance 5.0 m from the source?

A 1.1 W m^{-2} **B** 1.8 W m^{-2} **C** 2.5 W m^{-2} **D** 8.3 W m^{-2}

Ans: A

For a point source of sound that emits energy equally in all directions,

Intensity at a point, $I \propto \dfrac{1}{r^2}$ where *r* is the distance between the point and the source.

Therefore, $\dfrac{I'}{I} = \left(\dfrac{r}{r'}\right)^2$

$$\Rightarrow \frac{I'}{3.0} = \left(\frac{3.0}{5.0}\right)^2$$

$$\therefore I' = \left(\frac{3.0}{5.0}\right)^2 \times 3.0 = 1.1\,\mathrm{W\,m^{-2}}$$

16. A musical organ produces notes by blowing air into a set of pipes that are open at one end and closed at the other.

The speed of sound in the air in the pipes is 320 m s^{-1}.

What is the lowest frequency of sound produced by a pipe of length 2.0 m?

A 20 Hz **B** 40 Hz **C** 80 Hz **D** 160 Hz

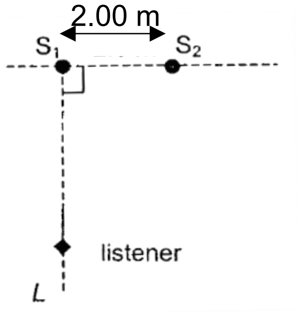
Ans: B

There is a node at the closed end and an antinode at the open end.
Therefore, at the fundamental (lowest) frequency,

Length of the pipe, $L = \dfrac{\lambda}{4}$

Therefore, lowest frequency of sound, $f = \dfrac{v}{\lambda} = \dfrac{v}{4L} = \dfrac{320}{4(2.0)} = 40\,\text{Hz}$

17. The figure below shows two speakers, S_1 and S_2, placed 2.00 m apart. The two speakers are both part of a stereo system connected to the same source, which produces sound of wavelength 1.00 m.



What is the distance from S_1 that a listener must be, along the line S_1L, for him to hear a minimum in sound intensity?

A 1.20 m **B** 1.50 m **C** 2.00 m **D** 3.75 m

Ans: D

For the listener to hear a *minimum* in sound intensity, path difference between the two waves must be *half a wavelength*.

Let the distance, between the listener, *L* and S_1 be *x*.

By Pythagoras Theorem, distance, between the listener, *L* and S_2 is $\sqrt{\left(x^2+2^2\right)}$

This means that path difference between the two waves at *L*, $\Delta x=\sqrt{\left(x^2+2^2\right)}-x$

Therefore, we have $\sqrt{\left(x^2+2^2\right)}-x=\dfrac{\lambda}{2}$

$$\Rightarrow \sqrt{\left(x^2+2^2\right)}-x=\frac{1.0}{2}$$

$$\sqrt{\left(x^2+2^2\right)}=x+0.5$$

$$x^2+2^2=\left(x+0.5\right)^2$$

$$x^2+2^2=x^2+x+0.5^2$$

$$x=2^2-0.5^2=3.75\text{ m}$$

18. Two wires of the same material and length are connected in series in an electrical circuit. One wire is thicker than the other.

Which of the following statements is true when a current flows in the circuit?

A The drift speed of electrons in the thicker wire is higher than the thinner wire.

B The drift speed of electrons in the thicker wire is lower than the thinner wire.

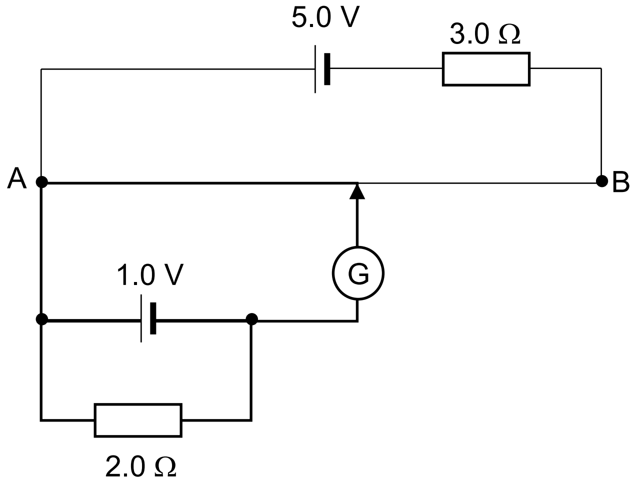
C The number density of charge carriers in the thicker wire is higher than the thinner wire.

D The number density of charge carriers in the thicker wire is lower than the thinner wire.

Ans: B

- Since both wires are in series they must have the same current $I = nAvq$.
- If they are made of the same material, they will have the same number density of charge carriers n.
- The charge carriers (electrons) all have the same charge $q = e$.
- So the thicker wire (bigger A) will have the lower drift speed v.

19. A potentiometer circuit using a 1.0 m resistance wire of resistance 1.0 Ω placed across AB is shown below. Both cells are ideal:

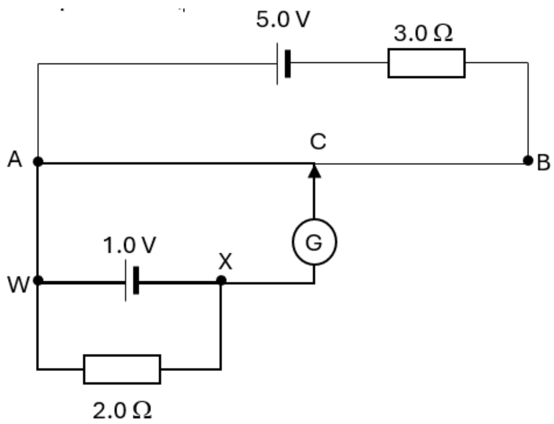


What is the balance length required for the galvanometer to show a null deflection?

A 20 cm **B** 50 cm **C** 60 cm **D** 80 cm

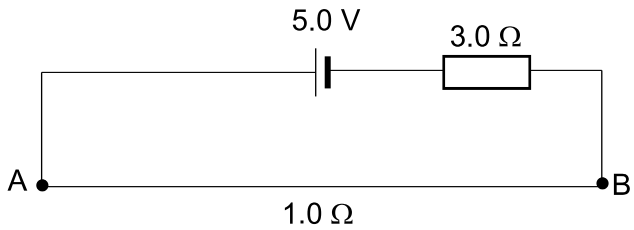
Ans: D

Let balance point be C;



At balance, $V_{AC} = V_{WX} = 1.0$ V
So what length of AC will give 1.0 V?

Find V_{AB} first. Look at the top circuit and use potential divider principle:



$$\frac{V_{AB}}{\text{e.m.f}} = \frac{R_{AB}}{\text{total resistance}}$$

$$\frac{V_{AB}}{5.0} = \frac{1.0}{1.0 + 3.0}$$

$$V_{AB} = 1.25 \text{ V}$$

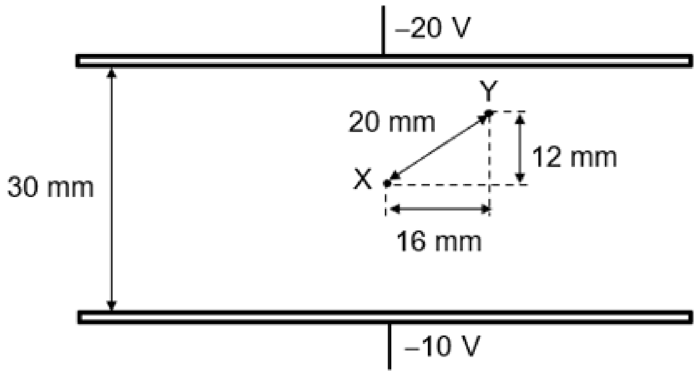
p.d. across AC is proportional to length AC.

$$\frac{\text{AC}}{\text{AB}} = \frac{V_{AC}}{V_{AB}}$$

$$\frac{\text{AC}}{1.0} = \frac{1.0}{1.25}$$

$$\text{AC} = 0.80 \text{ m}$$

20. The diagram shows two large horizontal metal plates situated 30 mm apart. The top and bottom plates are at potentials -20 V and -10 V respectively. The magnititude of the electric field between the plates is 333 V m^{-1}.



What is the work done by the electric field when a charge of -5.0 µC is moved from point X midway between the metal plates to point Y?

A -3.3 × 10^{-5} J

B -2.0 × 10^{-5} J

C 2.0 × 10^{-5} J

D 3.3 × 10^{-5} J

Ans: B

The electric field $E = \dfrac{-10-(-20)}{30 \times 10^{-3}} = 333 \text{ V m}^{-1}$ and it points upward (towards more negative plate)..

The electric force acting on the charge is $(5.0 \times 10^{-6})(333) = 1.67 \times 10^{-3}$ N, Since the charge is negative, the electric force is downward (opposite to electric field).

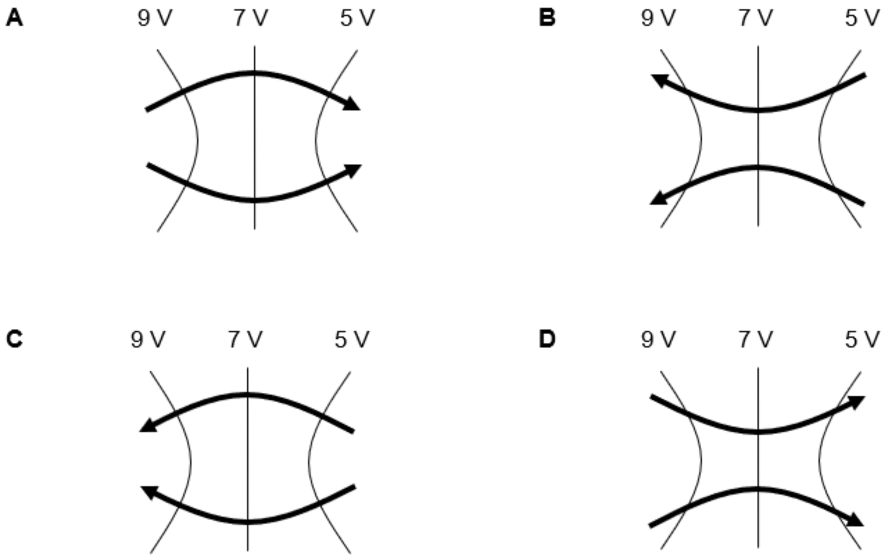
Work done by electric field $= qE \times d = (1.67 \times 10^{-3})(-0.012) = -2.0 \times 10^{-5}$ J.

Note: the distance moved parallel to the electric force is 12 mm, not 20 mm.

Also; the charge moved upward against the direction of the downward electric force, so the work done by the electric field should be negative.

21. In the following diagrams, the thin lines show equipotential lines and the bold arrows show the electric field lines and their directions.

Which set of equipotential lines and field lines is possible?

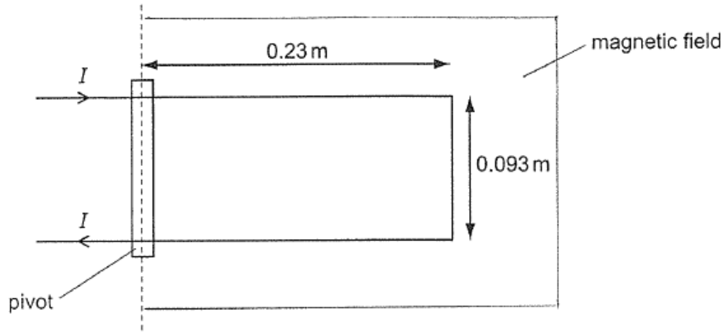


Ans: A

Electric fields point from higher electric potential to lower electric potential.

Electric field lines are perpendicular to equipotential lines.

22. A current, *I* of magnitude 9.6 mA is passed into a current balance which consists of a U-shaped wire of negligible mass placed in a region of constant magnetic field which is in the plane of the paper and perpendicular to the pivot. The U-shaped wire has length 0.23 m and the arms are 0.093 m apart, as shown in the diagram below.



The U-shaped wire experiences a turning moment about the pivot of value 4.7×10^{-6} N m

What is the magnitude of the magnetic flux density of the constant magnetic field?

A 5.27 mT **B** 22.9 mT **C** 45.8 mT **D** 4.37 T

Ans: B

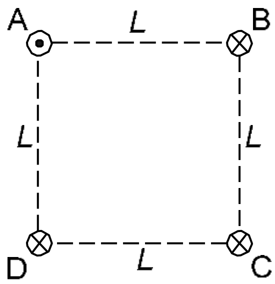
Magnetic force experienced by the wire, $F_B = BIL\sin\theta$

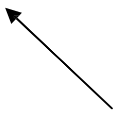
Moment produced, $F_B \times d = 4.7\times10^{-6} \Rightarrow (BIL\sin\theta)\times d = 4.7\times10^{-6}$

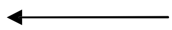
Therefore, magnetic flux density,

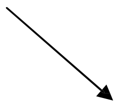
$$B = \frac{4.7\times10^{-6}}{(IL\sin\theta)d} = \frac{4.7\times10^{-6}}{(9.6\times10^{-3})(0.093)(\sin 90°)(0.23)} = 22.9\,\text{mT}$$

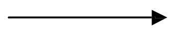
23. Four identical wires A, B, C and D carry currents, of equal magnitude, in the directions as shown in the figure below. What is the direction of the resultant magnetic force experienced by wire A?



A 

B 

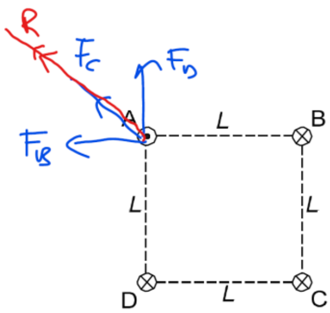
C 

D 

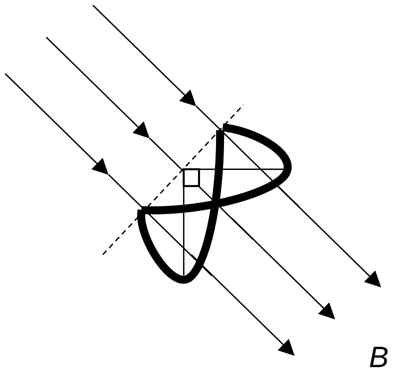
Ans: A

Parallel conductors carrying currents in the *opposite* direction will *repel* each other. So wire A is repelled by the other 3 wires.

Therefore, the resultant, *R* of the three forces acting on wire A is as shown below:



24. A closed circular loop of wire has a radius of 3.7 cm. It is bent along a diameter such that the two halves are perpendicular to each other. A uniform magnetic flux density of B = 76 mT is directed perpendicular to the fold diameter and makes equal angles (45°) with the planes of the semicircle.



If the magnetic flux density B is reduced to zero at a uniform rate during a time interval of 4.5 ms, what is the magnitude of the induced e.m.f in the loop?

A 0.026 V **B** 0.051 V **C** 0.073 V **D** 0.098 V

Ans: B

First we find the effective area that is perpendicular to the field. The magnetic field makes a 45 degree angle with each half of the semi circle. Thus the effective area is

$$A = 2 \times \frac{1}{2}\pi r^2 \times \cos(45^\circ)$$

Applying Faraday's law for the loop with decreasing magnetic flux:

$$\begin{aligned}
\varepsilon &= -\frac{d\phi}{dt} \approx -\frac{\Delta\phi}{\Delta t} \\
&= -\frac{\Delta B}{\Delta t} \times A \qquad (N = 1) \\
&= -\frac{0 - 76 \times 10^{-3}}{4.5 \times 10^{-3}} \times (2 \times \frac{1}{2}\pi r^2 \times \cos(45^\circ)) \\
&= 0.0514 \text{ V}
\end{aligned}$$

25. A plane flies through Canada from West to East where the Earth's magnetic field is inclined at an angle below the horizontal, into the Earth.

Which of the diagrams shows the correct accumulation of charges on the plane after some time has passed?

A

B

C

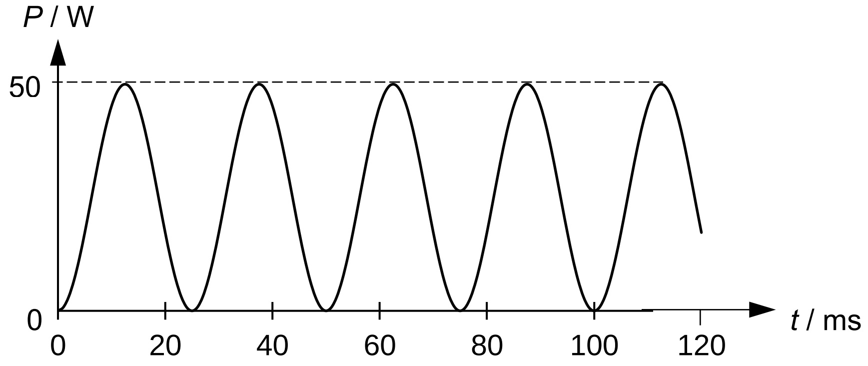
D

Ans: B

Consider the vertical component of the Earth's magnetic field (which is perpendicular to the wing)

Apply Fleming's LHR to show that the force acting on +ve particles is towards the left wing, so the force acting on -ve particles will point towards the right wing. Hence the right wing is negative and the left wing is positive.

26. A sinusoidal alternating supply is connected to a 10 Ω resistor in series. The graph shows how the power P dissipated across the resistor varies with time t.



What are the frequency f and the root-mean-square current $I_{\text{r.m.s.}}$ of the alternating supply?

	f / Hz	$I_{\text{r.m.s.}}$ / A
A	20	1.6
B	40	1.6
C	20	2.2
D	40	2.2

Ans: A

The period of the P-t graph is half the period of the current. The graph shows that 4 periods of the power = 100 ms = 2 periods of the current.

period of current, $T = \dfrac{100}{2} = 50$ ms

$$f = \frac{1}{50 \times 10^{-3}} = 20 \text{ Hz}$$

$$P_{\text{max}} = I_o^2 R$$

$$\text{Maximum current } I_o = \sqrt{\frac{50}{10}} = 2.24 \text{ A}$$

$$I_{r.m.s.} = \frac{2.24}{\sqrt{2}} = 1.58 \approx 1.6 \text{ A}$$

27. The minimum intensity of light that the human eye can detect is 2.0 x 10^{-11} W m^{-2}.

Given that the pupil of the eye has a diameter of 4.0 mm, how many photons per second of wavelength 550 nm must enter the eye for a distant star to be visible?

A 700 **B** 2800 **C** 1.3 x 10^9 **D** 5.1 x 10^9

Ans: A

$$\text{Minimum intensity } I = \frac{\textit{Minimum power received by eye}}{\textit{Area of pupil}}$$

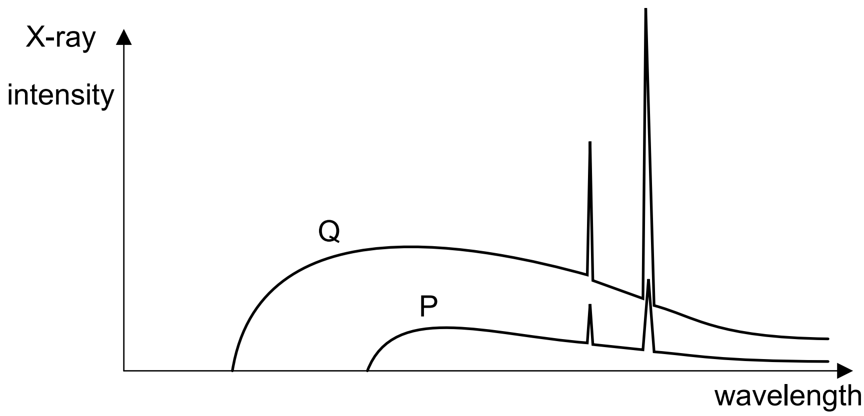
$$= \frac{(\textit{Rate of photon arrival})(\textit{Energy of each photon})}{\pi r^2}$$

$$= \frac{\frac{N}{t} h f}{\pi r^2} = \frac{\frac{N}{t} h \frac{c}{\lambda}}{\pi r^2}$$

$$2.0 \times 10^{-11} = \frac{\frac{N}{t}\left(6.63 \times 10^{-34}\right) \frac{3.00 \times 10^8}{550 \times 10^{-9}}}{\pi\left(0.002\right)^2}$$

$$\frac{N}{t} = 700 \text{ (2sf)}$$

28. In the figure below, graph P shows an X-ray spectrum from an X-ray tube.



What are the possible changes that can be made to obtain graph Q?

A Change the target metal.

B Increase the filament current of the cathode.

C Reduce the distance between the cathode and the target.

D Increase the potential difference between the cathode and target.

Ans: D

Increasing the p.d. mean that the bombarding electrons will have higher ke. This will result in a smaller minimum wavelength of X-ray produced when the electrons strike the metal target. The overall intensity will also increase as the chance of emitting X-ray photons will be higher due to the higher energy electrons striking the target.

29. Which of the following statements is true?

A α particles can be stopped by 1 m of lead.
B β particles can be deflected when travelling parallel to a magnetic field.
C γ particles can be stopped by paper.
D α, β and γ particles are all charged particles.

Ans: A

Option A: if α particles can be stopped by a thin piece of paper, it can surely be stopped by 1 m of lead.

Option B: β particles, which are charged particles, travelling parallel to a magnetic field will not experience a magnetic force. They need to cut across the magnetic field to experience a magnetic force.

Option C: γ particles (or rays) can only be stopped by about 10 cm of lead. They can't be stopped by paper.

Option D: γ particles (or rays) are uncharged electromagnetic radiation.

30. Technetium-99 has a half life of 6.0 hrs. It is used as a biological tracer. A sample of technetium-99 with an activity of 8.0×10^{10} Bq is injected into the bloodstream of a patient. 20 hours later, when the technetium-99 is assumed to be uniformly distributed throughout the blood of the patient, a 10 cm^3 blood sample is obtained. The activity from the sample is found to be 1.6×10^7 Bq.

What is the total volume of blood in the patient?

A 3100 cm^3 **B** 4700 cm^3 **C** 5000 cm^3 **D** 6300 cm^3

Ans: C

First, find activity of the entire sample after 20 hrs.

$$A = A_0 \, e^{-\lambda t}$$
$$= 8.0 \times 10^{10} \, e^{-(\ln 2 \times 20 / 6.0)}$$
` $$= 7.937 \times 10^9 \text{ Bq}$$

So $$\frac{\text{Total volume of blood}}{\text{Volume of blood sample}} = \frac{\text{Total activity after 20 hrs}}{\text{Activity of blood sample}}$$

$$\frac{\text{Total volume}}{10} = \frac{7.937 \times 10^9}{1.6 \times 10^7}$$
$$= 5000 \text{ cm}^3$$

End of paper