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2021 YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME ☐

CG ☐ INDEX NO ☐

PHYSICS

9749/01

Paper 1 Multiple Choice

17 September 2021

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.
Write your name and class on the Answer Sheet in the spaces provided unless this has been done for you.

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, $p = \rho g h$

gravitational potential, $\phi = -\frac{Gm}{r}$

temperature, $T/K = T/°C + 273.15$

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., $v = v_0 \cos \omega t$

$= \pm \omega \sqrt{(x_o^2 - x^2)}$

electric current, $I = Anvq$

resistors in series, $R = R_1 + R_2 + \ldots\ldots\ldots$

resistors in parallel, $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots$

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, $B = \frac{\mu_o I}{2\pi d}$

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, $\lambda = \frac{ln\,2}{t_{\frac{1}{2}}}$

1 The radiancy, R_T, is defined as the total energy emitted per unit time per unit area from a blackbody at thermodynamic temperature T. It was first stated empirically in 1879 in the form given by

$$R_T = \sigma T^4$$

where σ is called the Stefan-Boltzmann constant. Which of the following is the unit for σ?

A $\mathrm{W\,m^{-2}\,K^{4}}$ **B** $\mathrm{kg\,s^{-3}\,K^{-4}}$ **C** $\mathrm{J\,s\,m^{-2}\,K^{-4}}$ **D** $\mathrm{J\,s^{-1}\,m^{-2}\,K^{4}}$

2 A student measures the current through an ohmic conductor and the potential difference (p.d.) across it at a constant temperature. The measurements are then used to plot a graph of current against p.d.

There is a systematic error in the current measurements.

How could the systematic error be identified from the graph?

A The data points have a large scatter.

B The graph is a curve instead of a straight line.

C The line of best fit does not pass through the origin.

D At least one anomalous data point can be identified.

3 A car is travelling at close to the top speed on a Singapore expressway. The driver sees a large obstacle on the road and brings the car to a complete stop.

Which value is the best estimate of the car's change in momentum?

A 2×10^{2} kg m s^{-1}

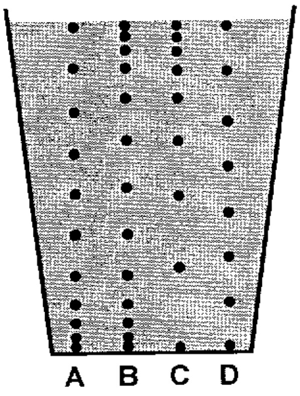
B 2×10^{4} kg m s^{-1}

C 2×10^{6} kg m s^{-1}

D 2×10^{8} kg m s^{-1}

4 When a bottle of fizzy drink is poured into a tall glass, gas bubbles are seen forming and rising to the surface. The dots in the diagram represent the gas bubbles. The time interval between successive dots is equal.

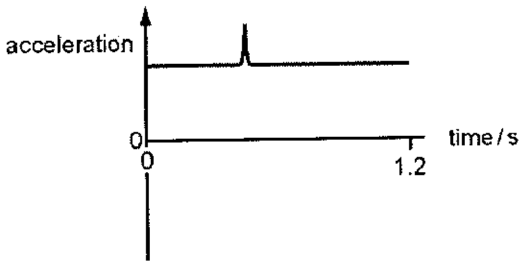
Assuming that there is no change in volume of the gas bubbles, which of the following options shows the path of the bubbles?



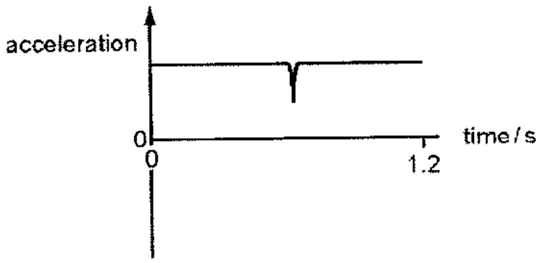
5 A student throws a ball vertically upwards. Upward velocities are taken as positive. The ball makes an elastic collision with the ceiling, rebounds and accelerates back to the student's hand in a time of 1.2 s.

Which graph best represents the acceleration of the ball from the moment it leaves the hand to the instant just before it returns to the hand?

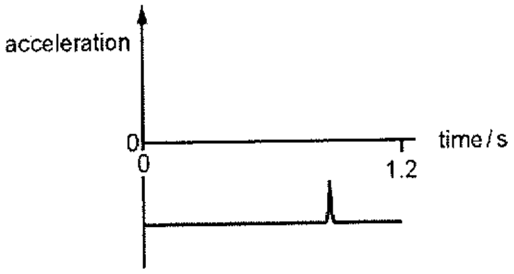
A



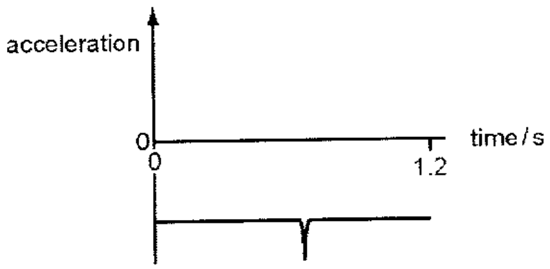
B



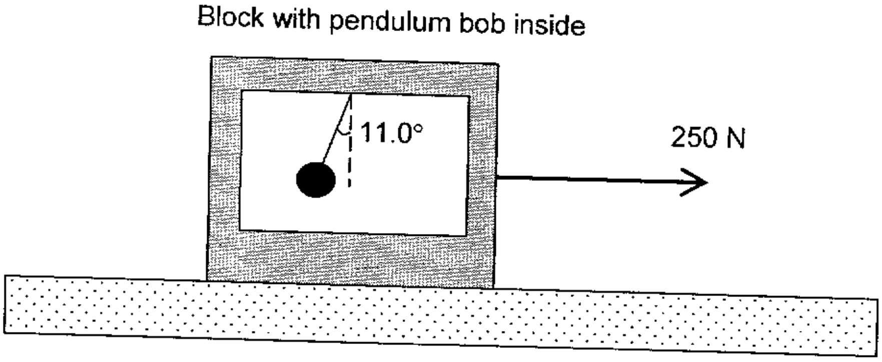
C



D



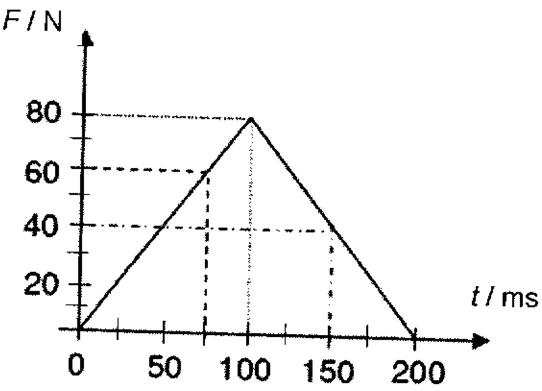
6 A block with a pendulum bob hanging inside lies on a rough horizontal surface. The total mass of the block and the pendulum bob is 100 kg. A force of 250 N is applied to the block and the pendulum bob makes an angle of 11.0° to the vertical axis.



What is the magnitude of the frictional force acting on the block?

A 28 N **B** 42 N **C** 59 N **D** 94 N

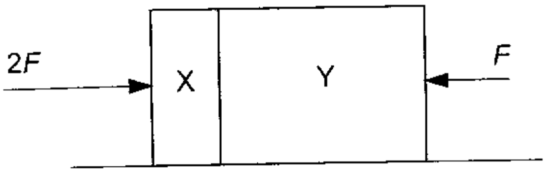
7 The variation of the force *F* with time *t* acting on a body of mass 200 g is as shown in the graph below.



Given that the velocity of the body at *t* = 75 ms is 15 m s^{-1}, what is the velocity of the body at *t* = 150 ms?

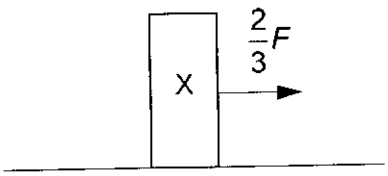
A 7.8 m s^{-1} **B** 30 m s^{-1} **C** 39 m s^{-1} **D** 55 m s^{-1}

8 Two blocks X and Y of masses *m* and 2*m* respectively are accelerated along a smooth horizontal surface by forces 2*F* and *F* applied to blocks X and Y respectively as shown.

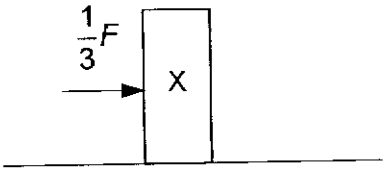


Which diagram **does not** correctly show the resultant force acting on the block(s)?

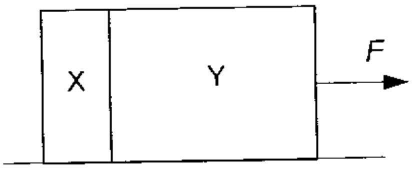
A



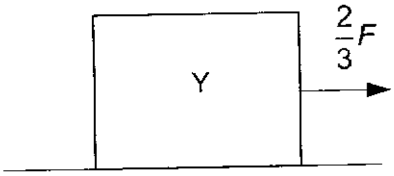
B



C



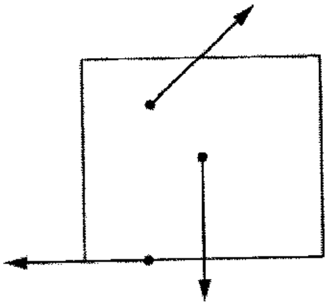
D



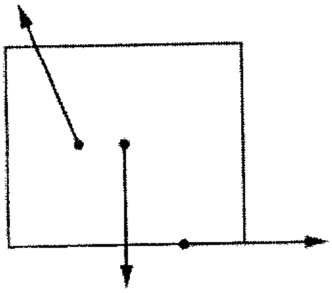
9 Three coplanar forces act on a block.

Which diagram shows the directions of the forces such that the block could be in equilibrium?

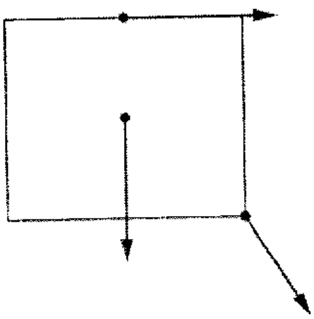
A



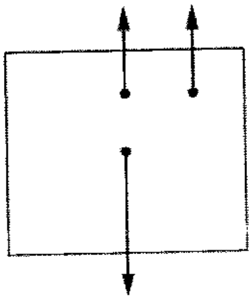
B



C



D



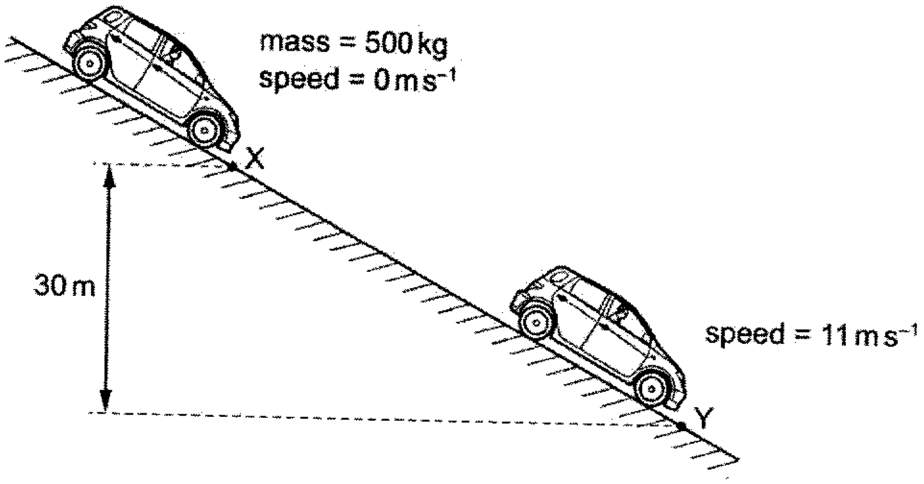
10 A steel sphere is dropped from rest vertically onto a horizontal metal plate. The sphere hits the plate with speed u, leaves it at speed v, and rebounds vertically to half of its original height. Ignore effects of air resistance.

Which expression gives the value of $\frac{v}{u}$?

A $\frac{1}{2^2}$ **B** $\frac{1}{2}$ **C** $\frac{1}{\sqrt{2}}$ **D** $1-\frac{1}{\sqrt{2}}$

11 A car of mass 500 kg is at rest at point X on a slope, as shown.

The car's brakes are released and the car rolls down the slope with its engine switched off. At point Y, the car has moved through a vertical height of 30 m and has a speed of 11 m s^{-1}.



What is the energy dissipated by frictional forces when the car moves from X to Y?

A 3.0×10^4 J **B** 1.2×10^5 J **C** 1.5×10^5 J **D** 1.8×10^5 J

12 A stone at the end of a string is whirled in a vertical circle at a constant speed.
Which of the following statements is correct?

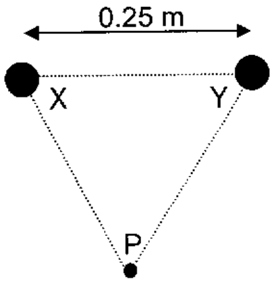
A The tension in the string stays constant.

B The tension is least when the stone reaches the bottom of the circle.

C The weight of the stone is always the centripetal force.

D The tension is greatest when the stone is at the bottom of the circle.

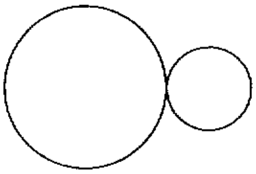
13 Two point masses, each of 8000 kg are placed 0.25 m apart at points X and Y as shown in the figure below. Points XYP form an equilateral triangle.



What is the gravitational potential energy of a mass of 5.0 kg placed at point P?

A -1.1×10^{-5} J **B** -2.1×10^{-5} J **C** -4.3×10^{-5} J **D** -8.5×10^{-5} J

14 Two iron spheres of different radii are in thermal contact in a vacuum as shown.



The spheres are at the same temperature.

Which statement **must** be correct?

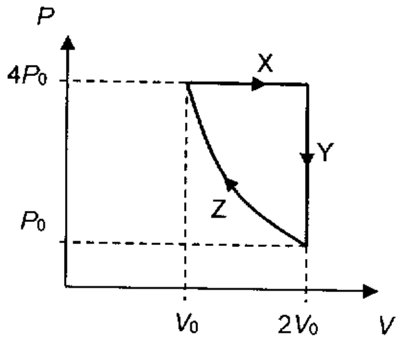
A There is no net transfer of thermal energy between the spheres.

B Both spheres have the same internal energy.

C Both spheres have the same heat capacity.

D The larger sphere has a greater mean internal energy per atom than the smaller sphere.

15 A fixed mass of monatomic ideal gas undergoes a constant pressure expansion to double its initial volume. Its pressure is then reduced to a quarter of the original at constant volume. The gas is then returned to its initial state in the process shown in the P–V diagram below.



Which of the following statements about the processes is **not** necessarily true?

A There is no heat exchange in process Z.

B Work done by the gas in process X is $4P_0V_0$.

C Heat is removed from the system in process Y.

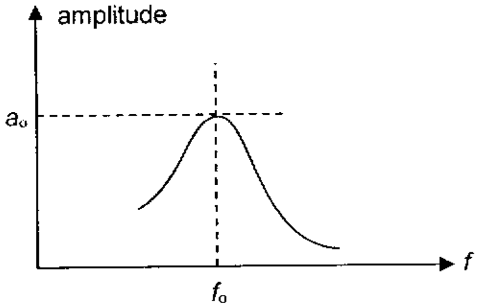
D Temperature of the gas is doubled in process X.

16 Four different solids **A**, **B**, **C** and **D** of equal masses at 20°C are separately heated at the same rate. Their melting points and specific heat capacities are as shown below.

Which of these solids will start to melt first?

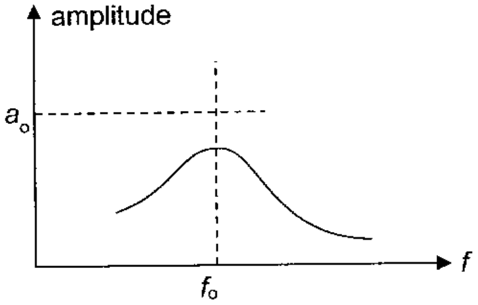
Solid	Melting point / °C	Specific heat capacity / J kg^{-1} K^{-1}
A	80	1200
B	100	800
C	150	600
D	300	250

17 A pendulum is constructed from a fixed length of light thread and a spherical, polystyrene bob of low density. It is forced to oscillate in air at different frequencies f. The following diagram shows how the amplitude of its oscillation varies with f.

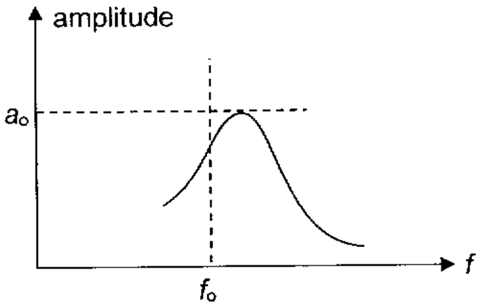


If the experiment is repeated in a partial vacuum, which graph best represents the variation with f of the amplitude?

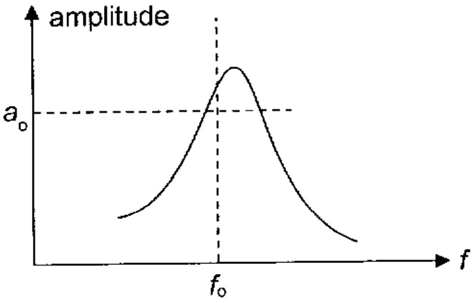
A



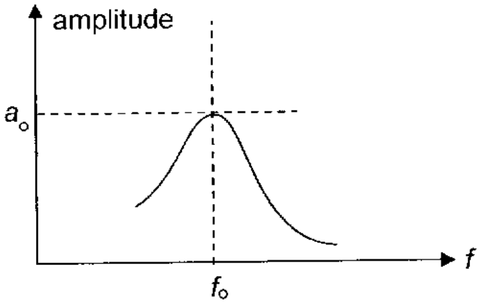
B



C



D

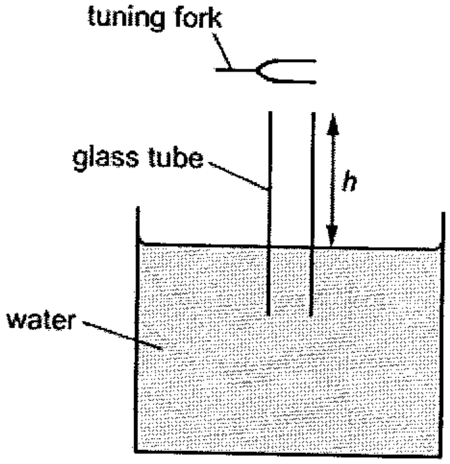


18 A sheet of glass transmits 70% of the energy of the incident light.

What is the value of the quantity $\frac{\text{amplitude of the transmitted light}}{\text{amplitude of the incident light}}$?

A 0.49 **B** 0.70 **C** 0.84 **D** 1.2

19 A long glass tube is almost completely immersed in a large tank of water. A tuning fork is struck and held just above the open end of the tube as it is slowly raised. A louder sound is first heard when the height *h* of the end of the tube above the water is 18.8 cm. A louder sound is next heard when *h* is 56.4 cm. The speed of sound in air is 330 m s^{-1}.

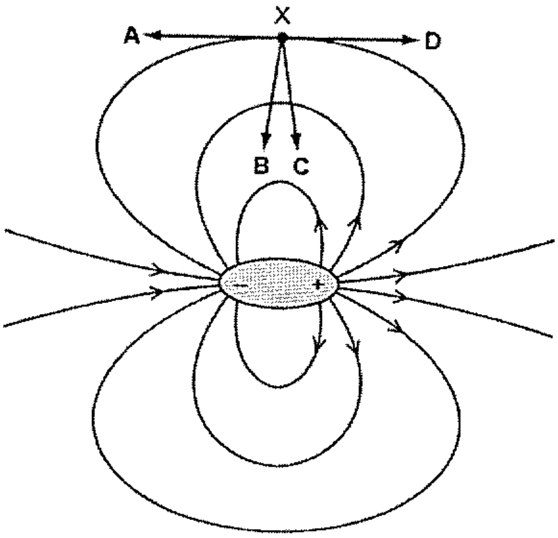


What is the frequency of the sound produced by the tuning fork?

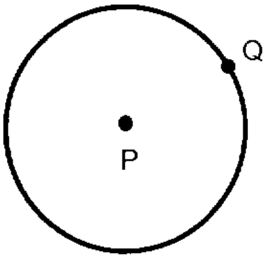
A 220 Hz **B** 440 Hz **C** 660 Hz **D** 880 Hz

20 A dipole consists of a pair of negative charge and positive charge of equal magnitude. The electric field of a dipole is shown below.

In which direction does the force act on an electron when placed at point X?



21 The hollow metal sphere shown below is positively charged. Point P is at the centre of the sphere and point Q is on the surface of the sphere.



Which of the following is **true** of the electric potential at these points?

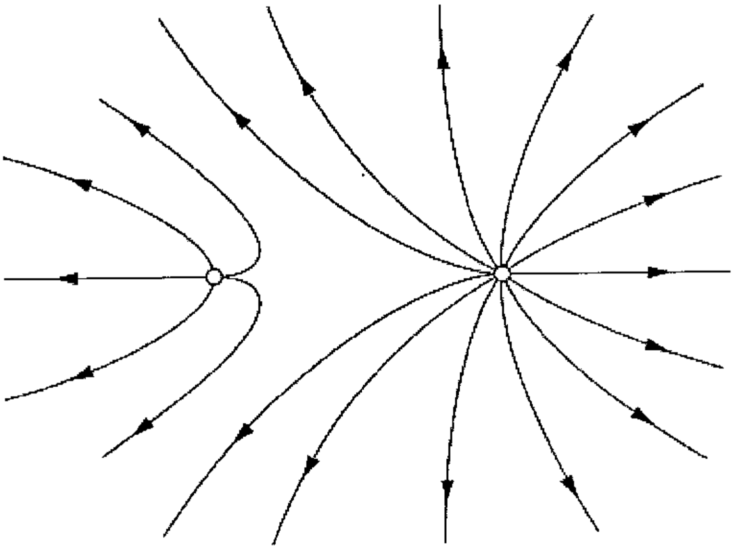
A P and Q have the same non-zero electric potential.

B It is zero at P but it is not zero at Q.

C It is zero at Q but it is not zero at P.

D It is zero at P and Q.

22 The electric field pattern around two charges of +1.0 μC and +4.0 μC is shown below.



The distance between the two charges is 6.0 cm.

There is a point of zero field strength along the line joining the two charges.

Which of the following could be the location of this point from the 1.0 μC charge?

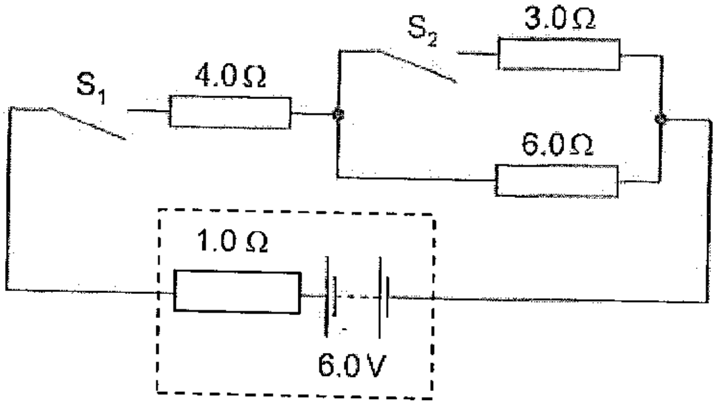
A 4.0 cm to the right of the +4.0 μC charge

B 2.0 cm to the left of the +4.0 μC charge

C 2.0 cm to the right of the +1.0 μC charge

D 4.0 cm to the left of the +1.0 μC charge

23 A battery of e.m.f. 6.0 V and internal resistance 1.0 Ω is connected to a network of resistors and switches.



At time t = 0, switches S_1 and S_2 are closed.

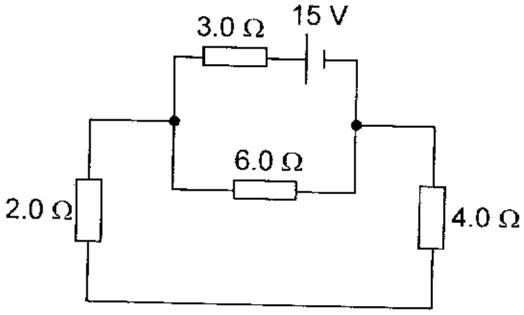
At time t = 2.0 minutes, S_2 is opened.

At time t = 4.5 minutes, S_1 is opened.

How much charge passes through the cell during the 4.5 minutes before S_1 is opened?

A 100 C **B** 130 C **C** 180 C **D** 210 C

24 The diagram shows four resistors connected to a 15 V battery of negligible internal resistance.



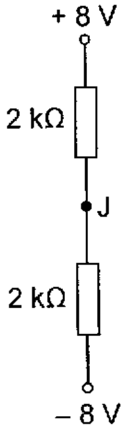
What is the potential difference across the 6.0 Ω resistor?

A 2.5 V **B** 6.0 V **C** 7.5 V **D** 10 V

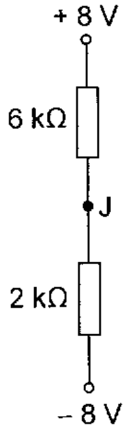
[Turn over

25 In which arrangement is the potential at J equal to – 4 V?

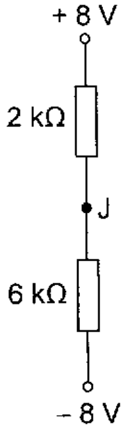
A



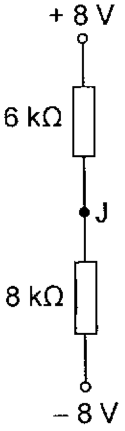
B



C



D



26 Two parallel wires, each carrying a current I in opposite directions repel each other with a force F.

If both currents are doubled, what is the new force of repulsion?

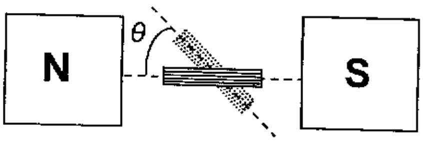
A F **B** $2F$ **C** $4F$ **D** $8F$

27 An electron moves in a circular path in a magnetic field of flux density 1.0 mT.

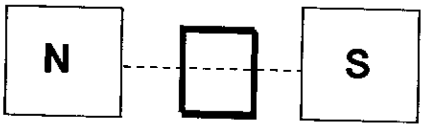
If a proton is to move in an identical path with the same speed and travelling in the same direction of rotation, what must the magnetic flux density be?

	magnitude / mT	direction
A	1800	same
B	1800	opposite
C	18	same
D	18	opposite

28 The figure below shows the side and top view of a coil of wire rotating in a uniform magnetic field.

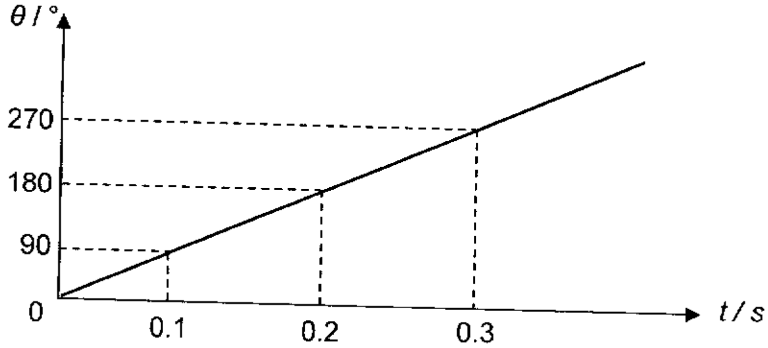


Side View



Top View

The graph below shows the variation of the angle θ with time t.



Which of the following statements is false?

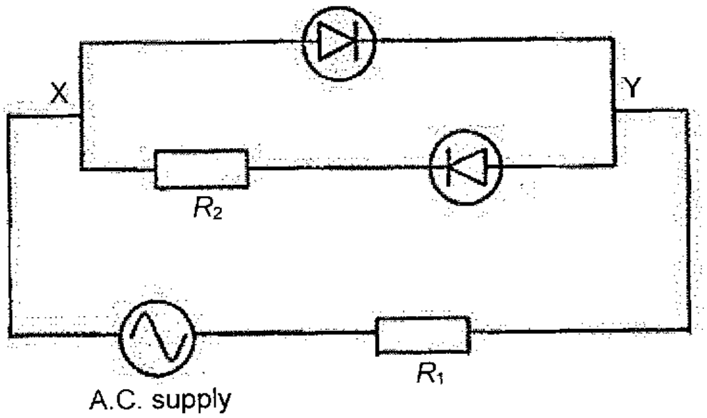
A The magnitude of the angular velocity is a constant.

B The maximum magnitude of induced e.m.f occurs at 0.4 s.

C The maximum magnitude of flux linkage experienced occurs at 0.4 s.

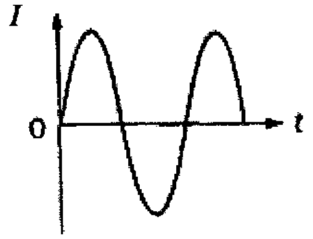
D The induced e.m.f. follows a sinusoidal function.

29 A circuit consists of an A.C. supply, two diodes, and two resistors with resistance R_1 and R_2 respectively.

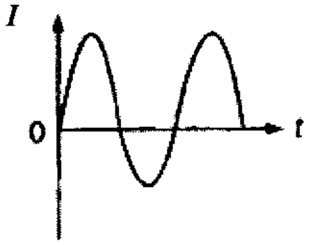


Which of the following graphs below represents the variation of current I with time t through R_1 of the circuit in the diagram above?

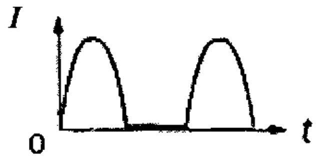
A



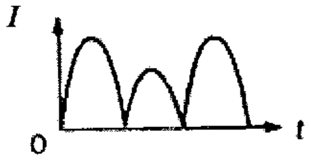
B



C



D



30 The energy levels in a hydrogen atom are shown.

energy level n	energy / eV
1	−13.6
2	−3.4
3	−1.5
4	−0.9
5	−0.5

A red spectral line known as the hydrogen alpha-line has been of great value to astronomers. Its wavelength is 656.28 nm.

Which level changes gives rise to the hydrogen alpha-line?

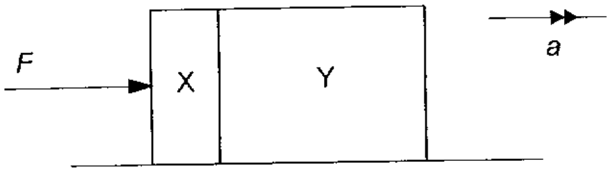
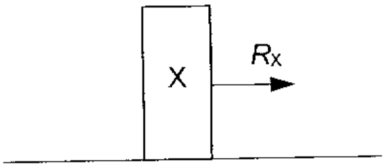
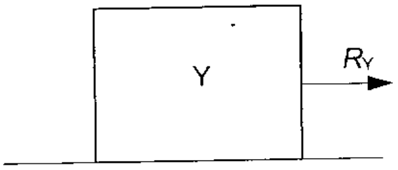
A 2 to 1 **B** 3 to 1 **C** 3 to 2 **D** 5 to 2

2021 YIJC JC2 H2 Preliminary Examination Physics Paper 1 Answer Key

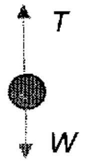
Question	Answer	Question	Answer	Question	Answer
1	**B**	11	**B**	21	**A**
2	**C**	12	**D**	22	**C**
3	**B**	13	**B**	23	**C**
4	**A**	14	**A**	24	**C**
5	**D**	15	**A**	25	**B**
6	**C**	16	**B**	26	**C**
7	**C**	17	**C**	27	**B**
8	**A**	18	**C**	28	**C**
9	**B**	19	**B**	29	**B**
10	**C**	20	**D**	30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

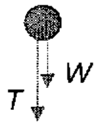
2021 YIJC JC2 H2 Preliminary Examination Paper 1 Suggested Solutions

S/N	Answer	Explanation
1	**B**	$[\sigma]$ $= \dfrac{[\text{energy}]}{[\text{time}][\text{area}][T^4]} = \dfrac{\text{J}}{\text{s m}^2\ \text{K}^4} = \dfrac{\text{kg m s}^{-2}\ \text{m}}{\text{s m}^2\ \text{K}^4}$ $= \text{kg s}^{-3}\ \text{K}^{-4}$
2	**C**	**A** implies large random error. **B** implies non-ohmic conductor. **C** Graph should be a straight line passing through the origin if no systematic error. **D** implies a possible error in the experiment (one data point)
3	**B**	Estimation of values required: Mass of car = 1000 kg Speed limit on expressway = 90 km h^{-1} $\Delta p = 1000\ (\frac{90 \times 1000}{3600} - 0) = 25\ 000 = 2.5 \times 10^4$ kg m s^{-1}
4	**A**	The gas bubbles initially accelerate upwards before travelling at a terminal velocity. Hence, spacing between bubbles increases before becoming constant.
5	**D**	Take vertically upwards as positive direction, the acceleration (g) of the ball before and after the collision with the ceiling is negative (downwards). During collision with the ceiling, the ball experiences an downward force from the ceiling and together with its weight leads to a larger negative (downwards) acceleration.

6	**C**	For the bob, $T \cos 11° = mg$ and $T \sin 11° = ma$ $\Rightarrow \tan 11° = a / g$ $\Rightarrow a = g \tan 11° = 1.90687 \text{ m s}^{-2}$ For the block and bob, $\sum F = (\sum m)\, a$ $250 - F_f = 100 \times 1.90687$ $F_f = 59.3 \text{ N}$
7	**C**	Area under *F-t* graph gives the change in momentum of the body. From $t = 75$ ms to $t = 150$ ms, $\Delta p = mv - mu = ½ (60 + 80)(100 - 75)(10^{-3}) + ½ (80 + 40)(150 - 100)(10^{-3})$ $= 4.75$ $\therefore mv = 4.75 + mu = 4.75 + (0.200)(15) = 7.75$ $\therefore v = 7.75 / 0.200 = 38.8 \text{ m s}^{-1}$
8	**A**	The resultant force acting on both blocks could be shown below.  Hence, $F = 3\, ma$ $a = F / 3m$ For Block X, let resultant force = R_X  $R_X = ma = \frac{1}{3}F$ For Block Y, let resultant force = R_Y  $R_Y = 2\, ma = \frac{2}{3}F$

9	B	For an object to be in equilibrium with three coplanar forces acting on it, (a) The vector sum of the three forces must form a closed loop diagram. (Option C not possible) (b) Net moment about any point must be zero. (Option D not possible) (c) Line of action of the three forces must pass through a common point (Option A not possible)
10	C	Assume the sphere is dropped from a height *h*. Considering its downward motion to the plate, Gain in KE = Loss in GPE, $\frac{1}{2}mu^2 = mgh$ $u^2 = 2gh$ Upon rebound, considering its upward motion to its maximum height, Loss in KE = Gain in GPE, $\frac{1}{2}mv^2 = mg\left(\frac{1}{2}h\right)$ $v^2 = gh$ Hence, $\frac{v^2}{u^2} = \frac{gh}{2gh}$ $\left(\frac{v}{u}\right)^2 = \frac{1}{2}$ $\frac{v}{u} = \frac{1}{\sqrt{2}}$
11	B	Using conservation of energy, $KE_X + GPE_X$ + Energy input = $KE_Y + GPE_Y$ + Work Done by dissipative forces Taking Y as the reference point, $0 + mgh_X + 0 = ½\, mv_Y{}^2 + 0$ + Energy by frictional forces Energy by frictional forces = $500(9.81)(30) - ½(500)(11)^2$ $= 1.2 \times 10^5$ J

<table>
<tr><td>12</td><td>D</td><td>At the bottom of the circle,

$T - W = mv^2 / r$
$T = W + mv^2 / r$

At the top of the circle,

$T + W = mv^2 / r$
$T = mv^2 / r - W$

<i>Hence, the tension is greatest when the stone is at the bottom of the circle.</i></td></tr>
<tr><td>13</td><td>B</td><td>GPE = Scalar sum of the GPE between masses at X and P and between masses at Y and P
$= -\frac{GM_X m_P}{XP} + \left(-\frac{GM_Y m_P}{YP}\right)$
$= -2\frac{(6.67\times10^{-11})(8000)(5)}{0.25}$
$= -2.1\times10^{-5}\text{ J}$</td></tr>
<tr><td>14</td><td>A</td><td>Thermal equilibrium ⇒ same temperature ⇒ no net transfer of thermal energy</td></tr>
<tr><td>15</td><td>A</td><td>Option A: The increase in internal energy for process Z is $6/2P_0V_0$, while the work done on the gas is less than $5/2P_0V_0$ (This will be the area under the graph if process C is a straight line process). So there is non-zero heat flow into the gas.</td></tr>
<tr><td>16</td><td>B</td><td>
<table>
<tr><th>Solid</th><th>Melting point/ °C</th><th>Specific heat capacity/ J kg^{-1} K^{-1}</th><th>ΔT from 20 °C to melting pt</th><th>Energy required for 1 kg to reach melting point / kJ</th></tr>
<tr><td>A</td><td>80</td><td>1200</td><td>60</td><td>72</td></tr>
<tr><td>B</td><td>100</td><td>800</td><td>80</td><td>64</td></tr>
<tr><td>C</td><td>150</td><td>600</td><td>130</td><td>78</td></tr>
<tr><td>D</td><td>300</td><td>250</td><td>280</td><td>70</td></tr>
</table>
</td></tr>
</table>

		Based on the energy required for each solid to reach their melting point, solid B which requires the least amount of energy to reach its melting point will melt first since they are all heated at same rate ($E = Pt$)
17	**C**	With partial vacuum, the max amplitude would be larger and natural frequency would be larger, as the damping effect is less.
18	**C**	*Intensity* $\propto$ *energy* and *Intensity* $\propto$ (*amplitude*)^2 $\therefore$ *energy* $\propto$ (*amplitude*)^2 $E = k\,(A)^2$ --- (1), where E is the energy of the incident light, and A is the amplitude of the incident light. $0.70\,E = k\,(A_1)^2$ --- (2), where the unknown amplitude is A_1. $(2) / (1) \Rightarrow 0.70 = (A_1 / A)^2$ $\Rightarrow A_1 = 0.84\,A$
19	**B**	$\lambda / 4$ – end correction = 18.8 cm $3\lambda / 4$ – end correction = 56.4 cm λ = 75.2 cm => frequency = 440 Hz
20	**D**	The electric field pattern shows the direction that a small positive test charge would follow. At X, a small positive test charge will be in the direction of the (tangential) electric field (i.e. in A's direction). However, since the test charge is negative, the force on the electron is in the opposite direction (i.e. D)
21	**A**	The hollow metal sphere is a good electrical conductor and as such, excess charges on it will move until there is no potential difference across its surface nor within the sphere. The sphere is said to have an equipotential volume.
22	**C**	Based on the field pattern given, the smaller charge is on the left. Let x = distance between the neutral point and the smaller charge. At the neutral point (which is somewhere between the two charges), $E_1 = E_4$ $\frac{1}{4\pi\varepsilon_o}\frac{(1.0\mu\text{C})}{x^2} = \frac{1}{4\pi\varepsilon_o}\frac{(4.0\mu\text{C})}{(6.0\text{ cm} - x)^2}$ $\frac{1}{x^2} = \frac{4}{(6.0 - x)^2} \Rightarrow \frac{6.0 - x}{x} = 2.0$ x = 2.0 cm The location is 2.0 cm to the right of the smaller charge.

<table>
<tr><td>23</td><td>C</td><td>From $t = 0$ to $t = 2.0$ min, the current in the cell = $\dfrac{6.0}{4.0+(\frac{1}{3}+\frac{1}{6})^{-1}+1.0} = \dfrac{6}{7}$ A
From $t = 2.0$ min to $t = 4.5$ min, the current in the cell = $\dfrac{6.0}{4.0+6.0+1.0} = \dfrac{6}{11}$ A
Using Q = It,
total charge = $(\frac{6}{7})(2.0 \times 60) + (\frac{6}{11})(2.5 \times 60) = 184.7$ C = 180 C (to 2 s.f.)</td></tr>
<tr><td>24</td><td>C</td><td>The 2.0 Ω and 4.0 Ω resistors are in series. So effective resistance is 6.0 Ω.
This 6.0 Ω resistor is parallel to the given 6.0 Ω, which results in an effective resistance of 3.0 Ω.
This 3.0 Ω resistor is in series with the given 3.0 Ω.
Hence, 15 V is shared equally across both 3.0 Ω resistors.
Hence 7.5 V appears across the effective resistance of 3.0 Ω which means 7.5 V appears across the given 6.0 Ω resistor.</td></tr>
<tr><td>25</td><td>B</td><td>
<table>
<tr><th>Option</th><th>p.d. across both resistors</th><th>p.d. across top resistor</th><th>Potential of point J</th></tr>
<tr><td>A</td><td>8 – (–8) = 16 V</td><td>$\frac{2}{2+2} \times 16 = 8$ V</td><td>8 – V_J = 8
V_J = 0 V</td></tr>
<tr><td>B</td><td>16 V</td><td>$\frac{6}{6+2} \times 16 = 12$ V</td><td>8 – V_J = 12
V_J = –4 V
(as required)</td></tr>
<tr><td>C</td><td>16 V</td><td>$\frac{2}{2+6} \times 16 = 4$ V</td><td>8 – V_J = 4
V_J = 4 V</td></tr>
<tr><td>D</td><td>16 V</td><td>$\frac{6}{6+8} \times 16 = 6.86$ V</td><td>8 – V_J = 6.86
V_J = 1.14 V</td></tr>
</table>
</td></tr>
<tr><td>26</td><td>C</td><td>The force is directly proportional to the product of the currents.
Since both currents are doubled, the force is 4 times larger.</td></tr>
</table>

27	B	The magnetic force provides the centripetal force on the moving charge. $Bqv = \frac{mv^2}{r} \Rightarrow B = \frac{mv}{qr}$ The proton and the electron carry the same charge q but of opposite sign. For the proton to retrace the path of the electron with the same speed, the radius must be the same. Thus, the magnetic flux density is now $B_p = \frac{m_p v}{-qr}$ $\frac{B_p}{B_e} = -\frac{m_p}{m_e}$ $\frac{B_p}{1.0\text{ mT}} = -\frac{1.67\times10^{-27}}{9.11\times10^{-31}}$ $B_p = -1800\text{ mT}$ The field is in the opposite direction to the initial.
28	C	A: True. As $\omega = \frac{\theta}{t}$, from graph it is clear that angular velocity is a constant. B: True. At 0.4 s, the angle rotated is 360°, the rate of cutting of magnetic flux linkage is the largest possible. C: False. At 0.4 s, the angle rotated is 360°, the flux linkage is zero at that instant. D: True. The flux linkage follows the equation $NBA\sin(\omega t)$. So, induced e.m.f. will follow the equation of $-NBA\omega\cos(\omega t)$
29	B	When the potential at X is higher than the potential at Y, the total resistance in the circuit is R_1. Current flows from X to Y. Similarly, when the potential at Y is higher than the potential at X, the total resistance in the circuit increased to R_1 + R_2. Current flows from Y to X (opposite direction) and has a lower peak value compared to when it flows from X to Y.

30	**C**	The energy of the photon emitted corresponds to the transitions between the energy levels in the hydrogen atom. $\Delta E=\frac{hc}{\lambda}=\frac{(6.63\times10^{-34})(3.0\times10^{8})}{656.28\times10^{-9}}=3.03\times10^{-19}\,\text{J}=1.9\,\text{eV (2sf)}$ Option A : ΔE = (-3.4)-(-13.6) = 10.2 eV Option B : ΔE = (-1.5)-(-13.6) = 12.1 eV Option C : ΔE = (-1.5)-(-3.4) = 1.9 eV (Answer) Option D : ΔE = (-0.5)-(-3.4) = 2.9 eV Alternative method (without calculation) It should be noted that visible light range occurs for the Balmer series where the transition involves n = 2. So the answer is narrowed to C or D. Red light has the longest wavelength and so the energy transition must be the smallest. Likely n = 3 to n = 2.