TAMPINES MERIDIAN JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION

CANDIDATE NAME	( )
CIVICS GROUP	

H1 PHYSICS 8867/01

Paper 1: Multiple Choice **20 September 2024**
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

You do not need to submit this Booklet at the end of the examination.

Write in soft pencil.
Do not use paper clips, glue or correction fluid.
Write your name, class and index number on the Multiple Choice 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**, **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the Multiple Choice Answer Sheet.

Read the instructions on the Multiple Choice Answer Sheet.

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.

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
elementary charge	e	=	1.60×10^{-19} C
unified atomic mass constant	u	=	1.66×10^{-27} kg
rest mass of electron	m_e	=	9.11×10^{-31} kg
rest mass of proton	m_p	=	1.67×10^{-27} kg
the Avogadro constant	N_A	=	6.02×10^{23} mol^{-1}
gravitational constant	G	=	6.67×10^{-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	=	$u^2 + 2as$
resistors in series	R	=	$R_1 + R_2 + \ldots$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

1 Which list contains only SI base units?

A ampere, mole, joule, gram
B second, kelvin, ampere, kilogram
C kilogram, mole, metre, newton
D metre, coulomb, second, mole

2 What is a reasonable estimate for the volume of a pen?

A 0.10 cm^3 **B** 1.0 cm^3 **C** 10 cm^3 **D** 100 cm^3

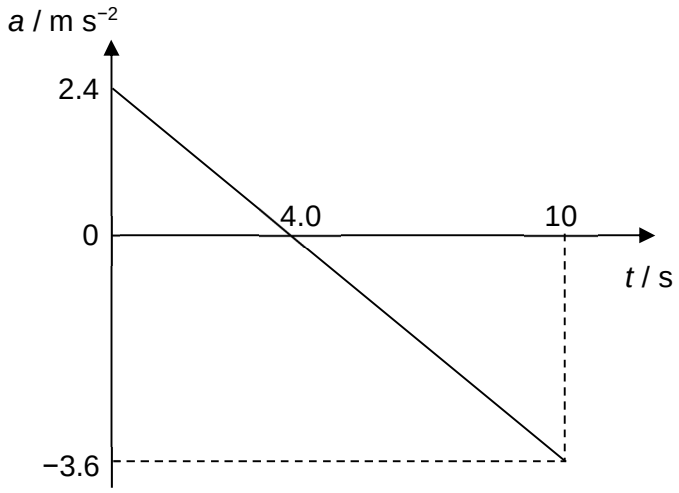
3 Which value is equivalent to 1.0 m?

A 1.0×10^{-3} mm **B** 1.0×10^{6} μm **C** 1.0×10^{-9} nm **D** 1.0×10^{12} Tm

4 Which of the following statements does **not** describe a random error?

A Random error can be eliminated.
B The magnitude of random error cannot be predicted.
C Random error is dependent on the instrument used for the measurement.
D Random error can be reduced by averaging repeated readings.

5 The diagram shows the variation with time t of the acceleration a of a body travelling in a straight line.



What is the change in velocity between $t = 0$ and $t = 10$ s?

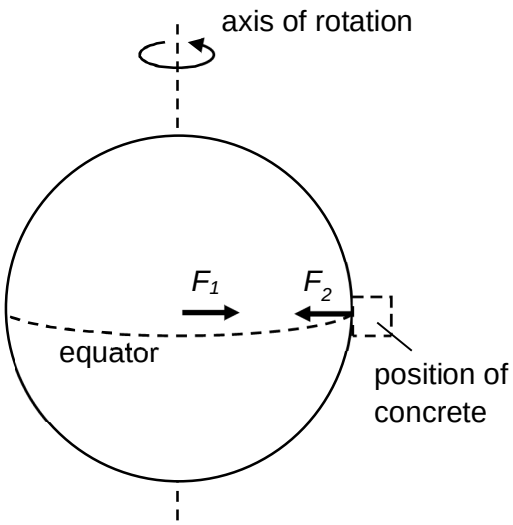
A zero **B** $-0.60\ \text{m s}^{-1}$ **C** $-6.0\ \text{m s}^{-1}$ **D** $-15.6\ \text{m s}^{-1}$

6 On the Earth, a long jumper took 1.0 s to land from his jump.

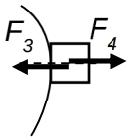
What is the equivalent time of flight and the maximum height if he makes a similar jump on the Moon where the acceleration of free fall is $\frac{1}{6}$ that on the Earth?

	time of flight / s	maximum height
A	6	6 times as high
B	6	6^2 times as high
C	$\sqrt{6}$	6 times as high
D	$\sqrt{6}$	6^2 times as high

7 A large block of concrete is placed on the ground at the equator where it is rotating with the Earth. The forces acting on the Earth and on the concrete are shown.



forces acting on the Earth

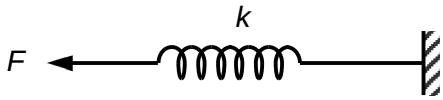


forces acting on the concrete

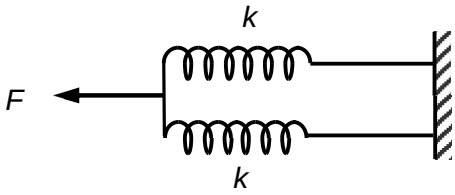
Which pairs of forces demonstrate Newton's 2nd Law & Newton's 3rd Law?

	Newton's 2nd Law	Newton's 3rd Law
A	F_3 and F_4	F_2 and F_4
B	F_3 and F_4	F_1 and F_2
C	F_1 and F_3	F_2 and F_4
D	F_1 and F_3	F_1 and F_2

8 A force *F* is applied on a spring of force constant *k.* The extension of the spring is *e*.



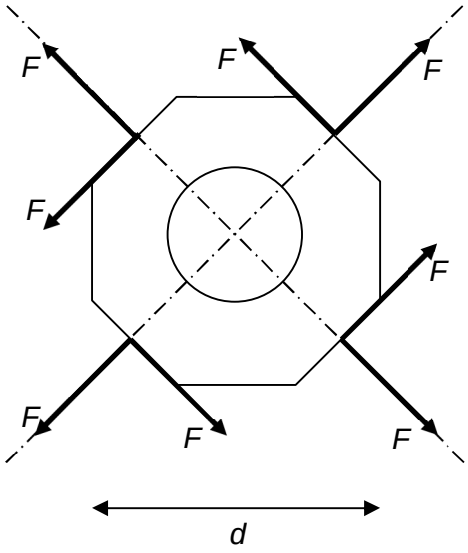
An identical spring is attached, and the same force *F* is applied to the new system of springs as shown below.



What is the resultant spring constant and the total elastic potential energy (EPE) stored in the new system?

	resultant spring constant	total EPE
A	$2k$	$\frac{ke^2}{4}$
B	$2k$	$\frac{ke^2}{8}$
C	$\frac{k}{2}$	$\frac{ke^2}{4}$
D	$\frac{k}{2}$	$\frac{ke^2}{8}$

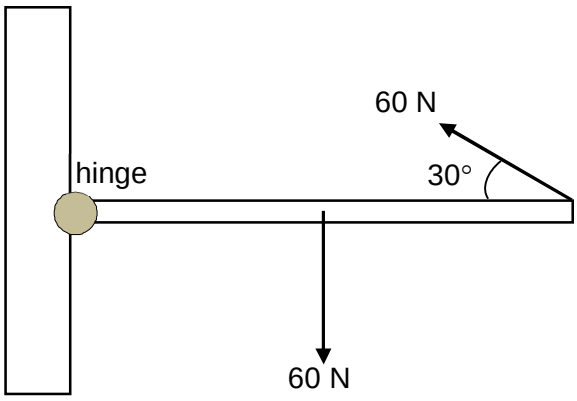
9 An octagonal shaped nut, of width d, is subjected to eight forces F as shown below. All forces are equal in magnitude.



What is the net torque caused by all the forces?

A Fd **B** $2Fd$ **C** $3Fd$ **D** $4Fd$

10 A uniform beam of weight 60 N is mounted to a wall by a hinge. The beam is kept horizontal by a rope at the other end which exerts a force of 60 N at an angle of 30° as shown below.

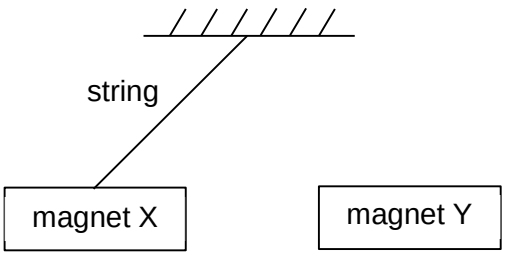


Which of the following is the value of the reaction force R at the hinge and the angle θ between R and the horizontal beam?

	R / N	θ / °
A	30	30
B	30	60
C	60	30
D	60	60

11 A horizontal magnet X is suspended by a string from the ceiling.

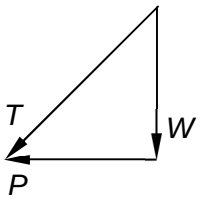
A magnet Y is brought close such that magnet X is held stationary as shown.



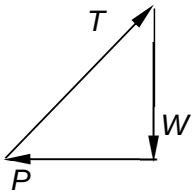
Magnet X has a weight of *W*. The magnetic force by magnet Y on magnet X is *P*. The tension in the string is *T*.

Which vector triangle represents the forces on the magnet X?

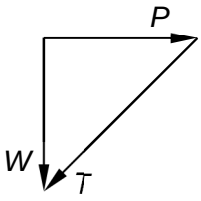
A



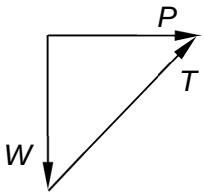
B



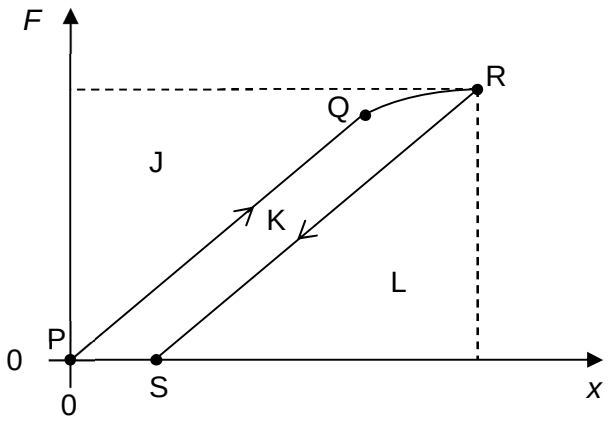
C



D



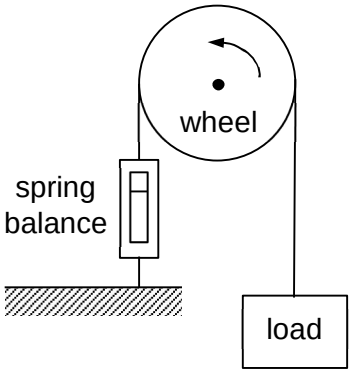
12 A metal wire is stretched by a varying force *F*, causing its extension *x* to increase as shown by the line PQR on the graph. The force is then gradually reduced to zero and the relation between the force and the extension is indicated by the line RS.



What area represents the work done on the wire at point R?

A J **B** K **C** L **D** K + L

13 The diagram shows a wheel of circumference 0.30 m which is driven by an electric motor. A rope is fastened at one end of the spring balance. The rope passes over the wheel and supports a freely hanging load of 100 N. When the wheel makes 50 revolutions per second, the balance reading is constant at 20 N.

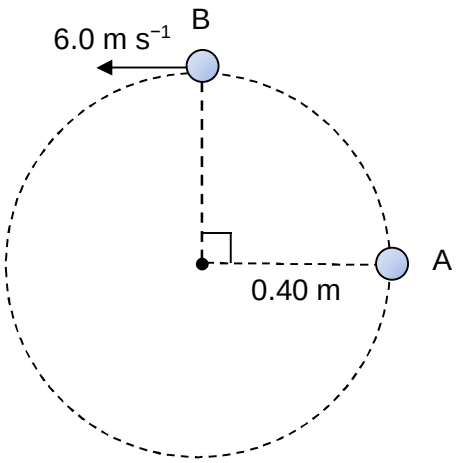


The efficiency of the motor is 20%.

What is the electrical power supplied to the motor?

A 240 W **B** 360 W **C** 6000 W **D** 9000 W

14 A body moves in a uniform circular motion from A to B as shown in the diagram. The radius of the circle is 0.40 m and the speed of the body is 6.0 m s^{-1}.



What is its angular velocity and angular displacement?

	angular velocity / rad s^{-1}	angular displacement / rad
A	2.4	0.63
B	2.4	1.6
C	15	0.63
D	15	1.6

15 On the surface of the Earth, the gravitational force on an object is *W*.

What is the gravitational force on the object when it is at a height of 2*R* above the surface of the Earth, where *R* is the radius of the Earth?

A $\frac{W}{2}$ **B** $\frac{W}{3}$ **C** $\frac{W}{4}$ **D** $\frac{W}{9}$

16 A communications satellite which takes 24 hours to orbit the Earth is replaced by a new satellite which has twice the mass of the old one.

The new satellite also has an orbit time of 24 hours.

What is the value of $\frac{\text{radius of orbit of new satellite}}{\text{radius of orbit of old satellite}}$?

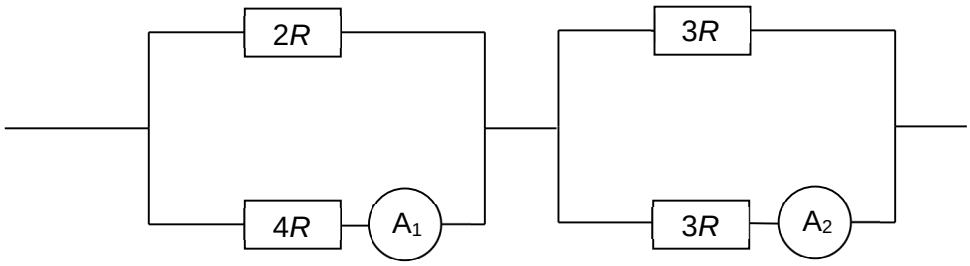
A $\frac{1}{2}$ **B** $\frac{1}{1}$ **C** $\frac{\sqrt{2}}{1}$ **D** $\frac{2}{1}$

17 The Moon takes 27.3 days to orbit the Earth. The centre of the Moon is 384 000 km from the centre of the Earth.

What is the linear speed of the Moon?

A 0.162 m s^{-1} **B** 1.02 m s^{-1} **C** 162 m s^{-1} **D** 1020 m s^{-1}

18 The ammeter A_1 in the circuit below reads 6.0 A.



What is the reading on ammeter A_2?

A 4.5 A **B** 6.0 A **C** 9.0 A **D** 18 A

19 A potential difference of 12 V is applied across a resistor for a time interval of 5.0 s. The current flowing through the resistor is 3.0 A.

Which of the following statements is **incorrect**?

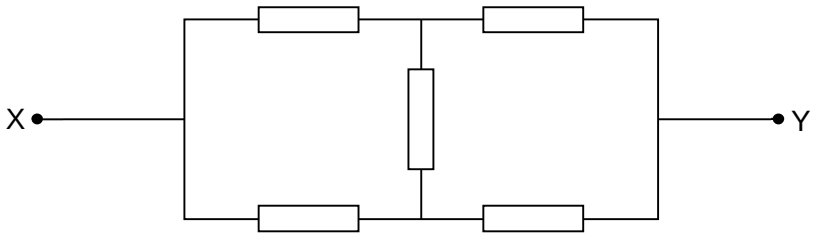
A The resistance of the resistor is 4.0 Ω.

B The energy dissipated in the resistor is 36 J.

C The charge passing through the resistor is 15 C.

D The potential difference across the resistor is 12 J C^{-1}.

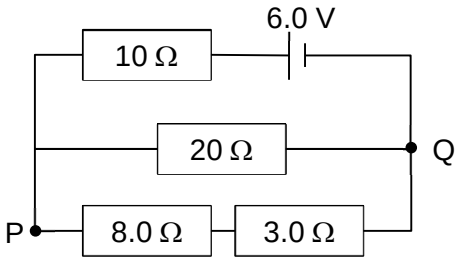
20 Five similar resistors each of resistance R are connected as shown below.



What is the effective resistance across points X and Y?

A $\frac{2R}{5}$ **B** R **C** 2R **D** $\frac{5R}{2}$

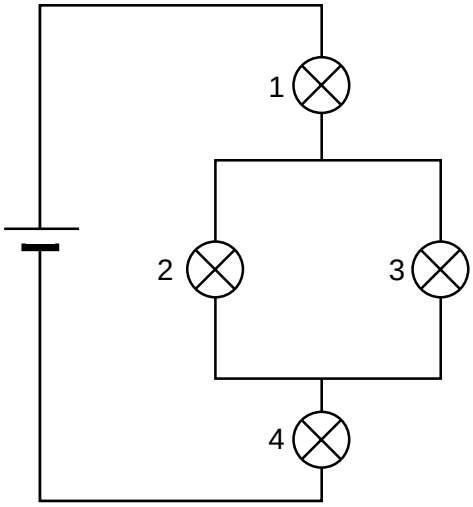
21 A battery with e.m.f. 6.0 V and negligible internal resistance is connected to several resistors as shown below.



What is the potential difference between P and Q?

A 1.6 V **B** 2.3 V **C** 2.5 V **D** 4.0 V

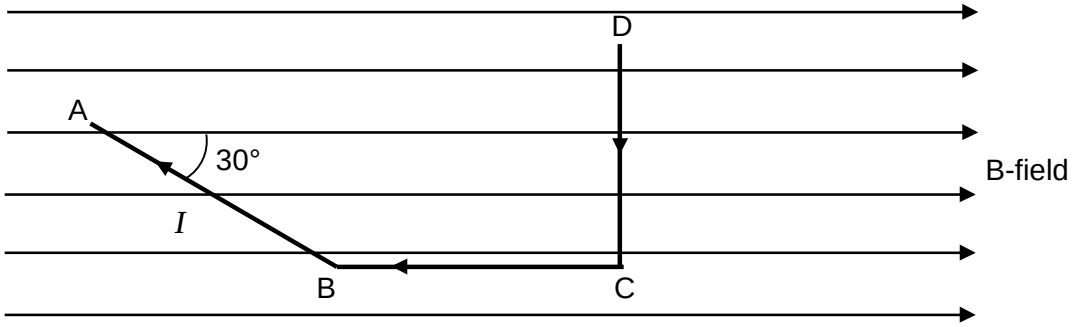
22 An ideal cell and four identical bulbs are connected as shown.



Bulb 3 is removed. Which of the following describes the changes in the brightness of bulbs 1, 2 and 4?

	Bulb 1	Bulb 2	Bulb 4
A	dimmer	brighter	dimmer
B	dimmer	brighter	brighter
C	brighter	dimmer	dimmer
D	brighter	dimmer	brighter

23 The figure below shows a wire ABCD placed in a uniform magnetic field of flux density 0.50 T. The current, I, flowing through the wire is 1.0 A. The lengths of AB, BC and CD are 20 cm each.



What is the net force on the wire ABCD?

A 0.050 N out of the plane of the paper

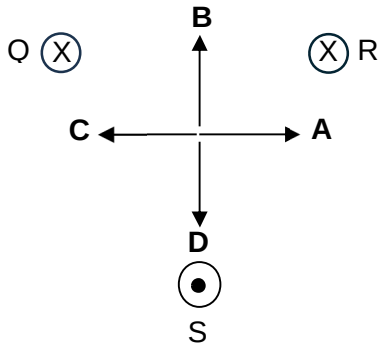
B 0.050 N into the plane of the paper

C 0.15 N out of the plane of the paper

D 0.15 N into the plane of the paper

24 Three wires, Q, R and S, are arranged in an equilateral triangle as shown. The currents in wires Q and R are directed into the plane of the paper, while current in wire S is directed out of the plane of the paper.

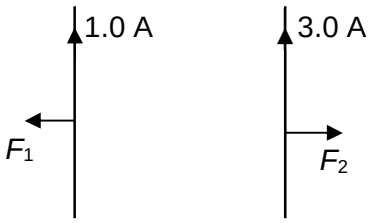
The direction of the magnetic field at the centre of the equilateral triangle is



25 Two long, straight, parallel wires carry currents of 1.0 A and 3.0 A in the same direction.

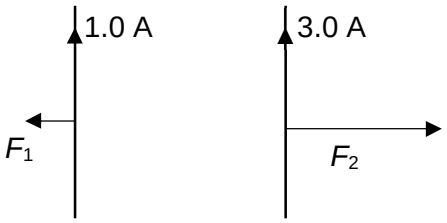
Which diagram shows the directions and relative magnitudes F_1 and F_2 of the force per unit length on each of the wires?

A



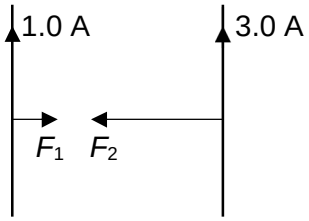
$F_1 = F_2$

B



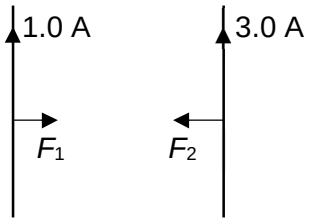
$3F_1 = F_2$

C



$3F_1 = F_2$

D



$F_1 = F_2$

26 A radioactive nuclide X decays by a series of alpha and beta decays.

Which series of decays will result in a nuclide which has the same number of protons as X but a different number of neutrons?

A one alpha and two beta decays

B one alpha and four beta decays

C two alpha and three beta decays

D two alpha and six beta decays

27 Which one of the following is an appropriate unit for the measurement of the mass defect of a nucleus? (c is the speed of light in m s^{-1})

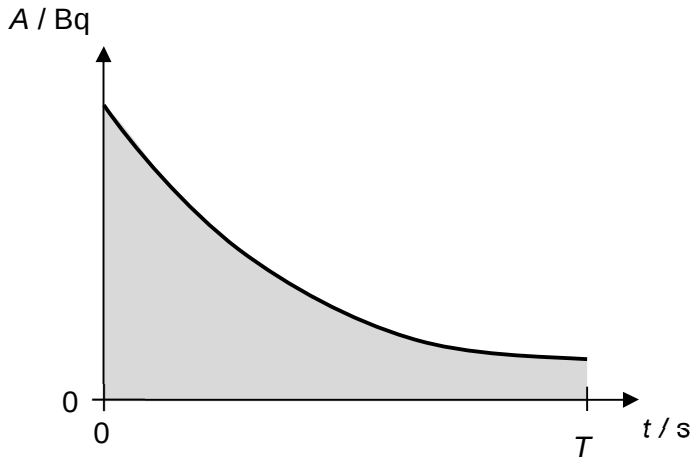
A MeV c^2

B MeV

C MeV c^{-1}

D MeV c^{-2}

28 The graph shows the variation with time *t* of the activity *A* of a pure sample of a radioactive nuclide. The total energy released due to radioactive decay of the sample in time *T* is *E*. The area of the shaded portion is *S*.



What does the quantity $\frac{E}{S}$ represent?

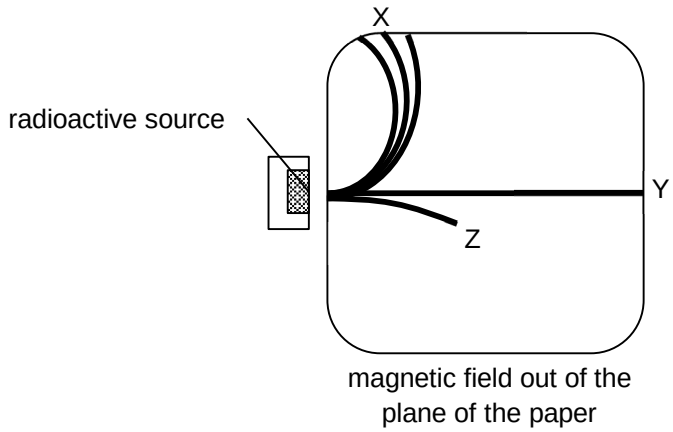
A The number of decays which occur in time *T*.

B The average power due to radioactive decay.

C The average energy produced in time *T*.

D The energy released for each radioactive decay.

29 Particles emitted by a radioactive source enter a region filled with air, in which there is a uniform magnetic field directed out of the plane of the paper. The paths of the radioactive particles in the magnetic field are shown.



Which radioactive particles are represented by the paths X, Y and Z respectively?

A $\alpha,\ \beta,\ \gamma$

B $\beta,\ \alpha,\ \gamma$

C $\beta,\ \gamma,\ \alpha$

D $\alpha,\ \gamma,\ \beta$

30 A detector placed close to a radioactive source measures an activity of 320 Bq. The background activity at this location is 20 Bq. The radioactive nuclide has a half-life of 12 hours.

What activity is measured after 9 hours?

A 178 Bq **B** 198 Bq **C** 225 Bq **D** 245 Bq

Tampines Meridian Junior College

2024 JC2 H1 Physics Preliminary Exam Paper 1 – Suggested Solution

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

Q1 Ans: B
joule, newton and coulomb are not SI base units.

Q2 Ans: C

Estimated length = 14.0 cm
Estimated diameter = 1.0 cm
Assuming the cross sectional area is a circle, volume $= \pi \left(\frac{1.0}{2} \right)^2 14.0$

$= 11\ cm^3$

Q3 Ans: B

1.0 m $= 1.0 \times 10^3$ mm $= 1.0 \times 10^6$ μm $= 1.0 \times 10^9$ nm $= 1.0 \times 10^{-12}$ Tm

Q4 Ans: A
Random error can be only reduced but not completely eliminated

Q5 Ans: C

Explanation
change in velocity = total area under graph
by similar triangle, *t*-intercept = 4.0 s
total area under graph = ½ × 4.0 × 2.4 + (−½ × 6.0 × 3.6) = −6.0 m s^{-1}

Q6 Ans: A

Explanation
first find the time of flight:

from launch to top: $v_y = u_y + a_y t \Rightarrow -u_y = u_y - gt \Rightarrow$ time of flight $t = \frac{2u_y}{g}$

u_y same but g is 1/6 times $\Rightarrow$ time of flight t is 6 times as long, i.e. 6 s

now find the maximum height H: $v_y^2 = u_y^2 + 2a_y s_y \Rightarrow 0 = u_y^2 - 2gH \Rightarrow H = \frac{u_y^2}{2g}$

u_y same but g is 1/6 times $\Rightarrow$ maximum height H is 6 times as high

(if we use $s_y = u_y t + \frac{1}{2} a_y t^2 \Rightarrow H = u_y t - \frac{1}{2} g t^2$, this is complicated to analyse because there is one positive t term and one negative t^2 term with g)

Q7 Ans: A

Newton's 2nd Law: The forces need to act on the same body (to produce a resultant force).
Hence, only the pair F_3 and F_4 satisfy this condition.

Newton's 3rd Law: The forces need to act on different body.
Hence, only the pair F_2 and F_4 satisfy this condition.

Q8 Ans: A

When there is a single spring; $F = ke$…… (1)

Two springs are now in parallel. Hence, the resultant spring constant is $2k$.

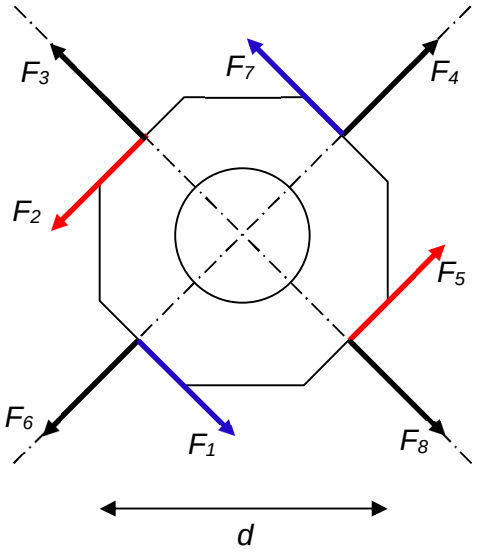
By Hooke's law, the new extension, e_{new}

$F = (2k)\, e_{new}$ …….(2)

From equations (1) & (2); $e_{new} = ½\, e$

Hence, total EPE = ½ (2k) $(e_{new})^2 = \frac{ke^2}{4}$

Q9 Ans: B



Torque of a couple = *Fd* (one set (blue arrows); another set (red arrows)

Hence, total torque = *Fd* + *Fd* = 2*Fd*
*The other forces pass through the cg; hence no torque is generated.

Q10 Ans: C

$R\cos\theta = 60\cos(30°)$
$R\sin\theta + 60\sin(30°) = 60$
Solving,
$R = 60$ N, $\theta = 30°$

Q11 Ans: B

$W + P + T = 0$
Tension *T* points away from magnet X.

Hence, by vector addition, all the vectors should form a closed loop.

Q12 Ans: D

Work done is area under force-extension (distance) graph.

Q13 Ans: C

Output power of the motor = (100 - 20)(0.30)(50) = 1200 W
Electrical power supplied to the motor = $\frac{1200}{0.2} = 6000$ W

Q14 Ans: D

Explanation

angular velocity = $\frac{v}{r} = \frac{6.0}{0.40} = 15$ rad s^{-1}

angular displacement = angle $= \frac{\pi}{2} = 1.6$ rad

Q15 Ans: D

Explanation

gravitational force $F = \frac{GMm}{r^2}$

on the ground, $F = W$ and $r = R$: $W = \frac{GMm}{R^2}$ …… equation 1

at a height $2R$ above the ground, $r = 3R$: $F = \frac{GMm}{(3R)^2}$ …… equation 2

equation 2 divide by equation 1 gives $F = \frac{W}{9}$

Q16 Ans: B

Explanation

for orbiting satellite:

gravitational force provides centripetal force

$$\frac{GMm}{r^2} = mr\left(\frac{2\pi}{T}\right)^2$$

$$T^2 = \frac{4\pi^2}{GM}r^3$$

the radius r of orbit is independent of the mass m of the satellite

so the radius is the same

Q17 Ans: D

Explanation

linear speed $v = \frac{2\pi r}{T} = \frac{2\pi \times 384\,000\,000}{27.3 \times 24 \times 60 \times 60}$ = 1020 m s^{-1}

Q18 Ans: C

Current through 2*R* resistor is $\frac{4R}{2R} \times 6 = 12 \text{ A}$.

Therefore, current through A_2 = $\frac{12+6}{2} = 9 \text{ A}$.

Q19 Ans: B

Since $Q = 3 \times 5 = 15\ C$ hence power dissipated = $I^2R = 3^2 \times 4$ = <u>36 W</u> (not energy)

Q20 Ans: B

Note that the middle resistor is redundant as the pd across it is the same, hence no current flow.

Hence $R_E = \left(\frac{1}{R+R} + \frac{1}{R+R} \right)^{-1} = R$

Q21 Ans: C

$R_{\text{eff across PQ}} = \left(\frac{1}{20} + \frac{1}{8+3} \right)^{-1}$ = 7.10 Ω

$V_{PQ} = \frac{R_{PQ}}{R_{PQ} + R_{10\Omega}} \times 6.0 = \frac{7.10}{7.10+10} \times 6.0 = 2.5$ V

Q22 Ans: A

With bulb 3 in parallel to bulb 2, the potential difference across bulb 2 is a smaller fraction of the cell's e.m.f as compared to that of bulbs 1 and 4.

With bulb 3 removed, the potential difference across bulb 2 increases while those of bulb 1 and bulb 4 decrease correspondingly. With fixed resistance, power dissipated increases as potential increases, hence bulbs 1 and 4 became dimmer and bulb 2 became brighter.

Q23 Ans: A

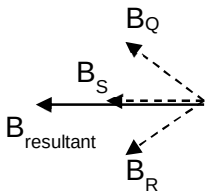
$F_{AB} = (0.50)(1.0)(0.20)\sin(30°) = 0.050$ N into the paper

$F_{BC} = (0.50)(1.0)(0.20)\sin(0°) = 0$ N

$F_{CD} = (0.50)(1.0)(0.20)\sin(90°) = 0.10$ N out of the paper

Net force $= 0.10 - 0.050 = 0.050$ out of the paper

Q24 Ans: C



Q25 Ans: D
By Fleming's Left Hand Rule, the forces on the respective wires act towards each other.
By Newton's 3rd Law, the forces are of equal magnitude.

Q26 Ans: A

Every alpha decay reduces the proton number by 2.
Every beta decay increases the proton number by 1.
Hence for one alpha decay followed by two beta decays, the proton number is unchanged and the product will be the same element as the original nuclide X, except that there will be four less neutrons (an isotope of the nuclide X).

Q27 Ans: D

The MeV (mega electron-volt) is a unit of energy. From the equation $E = mc^2$, we can obtain mass as energy divided by c^2.
Hence, MeV c^{-2} is a unit that can measure a quantity of mass.
The mass defect is the difference in mass between the nucleus and the individual separate nucleons that make up the nucleus, hence it is a quantity of mass.
So MeV c^{-2} can be used as a unit for the measurement of the mass defect.

Q28 Ans: D
Activity *A* is the number of decays per unit time.
The shaded area S is therefore the total number of decays in time *T*.

The value $\frac{E}{S}$ is the total energy of the decays in time *T* divided by the total number of decays, hence it is the energy released per radioactive decay.

Q29 Ans: C

Path X shows that the particles are deflected by a magnetic field, hence they are charged. They exhibit a range of trajectories, thus indicating that the particles have a continuous range of velocities. Hence the particles with path X are beta particles.

Path Y shows no deflection in a magnetic field, hence the particles are uncharged, and so they are gamma particles.

Path Z shows a short path which is deflected slightly. Hence, the particles are charged, travel a short distance in air, have the same velocity, deflect less than beta particles, and deflect in the opposite deflection as beta particles. Hence, they are alpha particles.

Q30 Ans: B

The corrected count rate initially is
320 – 20 = 300 Bq

The corrected count rate after 9 hours is

$$CCR = 300(\frac{1}{2})^{\frac{9}{12}} = 178 \text{ Bq}$$

The observed count rate after 9 hours is

C = 178 + 20 = 198 Bq

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