For 2016, only Q1 to Q21 are relevant.

Candidate's Name: ……..…. CTG: ……..…

YISHUN JUNIOR COLLEGE
JC 1 PROMOTIONAL EXAMINATION 2015

PHYSICS **9646/01**
HIGHER 2
Paper 1 **6 October 2015**
Tuesday
1 hour

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.
Write your name and CTG in the spaces provided on the cover page of this paper.

Write your name and CTG in the spaces provided on the Optical Mark Sheet (OMS).

On the OMS, shade your NRIC in the space provided.

There are **thirty** questions in this paper. For each question, there are 4 possible answers, **A**, **B**, **C** and **D**. Only one answer is correct.

Choose the correct answer and record your choice in soft pencil on the OMS. 1 mark will be awarded for each correct answer. No mark will be deducted for wrong answer.

This question paper consists of 17 printed pages, inclusive of the cover page.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_o	=	8.85×10^{-12} Fm^{-1} $(1 / (36\ \pi)) \times 10^{-9}$ Fm^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
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
molar gas constant,	R	=	8.31 J K^{-1} mol^{-1}
the Avogadro constant,	N_A	=	6.02×10^{23} mol^{-1}
the Boltzmann constant,	k	=	1.38×10^{-23} J K^{-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	=	$u^2 + 2as$
work done on/by a gas,	W	=	$p\Delta V$
hydrostatic pressure,	p	=	ρgh
gravitational potential,	ϕ	=	$-\frac{Gm}{r}$
displacement of particle in s.h.m.	x	=	$x_o \sin \omega t$
velocity of particle in s.h.m.	v	=	$v_o \cos \omega t$
		=	$\pm \omega\sqrt{\left(x_o^{\,2} - x^2\right)}$
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$
electric potential,	V	=	$Q / 4\pi\varepsilon_o r$
alternating current/voltage,	x	=	$x_o \sin \omega t$
transmission coefficient,	T	=	$\exp(-2kd)$
	where k	=	$\sqrt{\frac{8\pi^2 m(U-E)}{h^2}}$
radioactive decay,	x	=	$x_o \exp(-\lambda t)$
decay constant	λ	=	$\frac{0.693}{t_{1/2}}$

1 A ball bearing falling through oil experiences viscous force. The viscosity η of a liquid is given by the following equation, $\eta = \frac{kr^2}{v}$, where *k* is viscous force per unit volume of the ball bearing , *r* is the radius of the ball bearing and *v* is the speed of the ball bearing.

What is the S.I. unit of η ?

A N s m^{-1}

B N s m^{-2}

C N s^{-1} m^{-2}

D N s^{-1} m^{-3}

2 A student uses an analogue ammeter to read the current passing through a resistor. The ammeter is marked every 0.01 A but has a zero error of 0.08 A. The ammeter gives a reading of 2.16 A. The student then accounts for the zero error and writes down the current measurement to be 2.08 A.

Is the measurement accurate and precise?

	Accurate	**Precise**
A	No	No
B	No	Yes
C	Yes	No
D	Yes	Yes

3 A student proposed that the relationship between four physical quantities follows the equation $P = Q - R\,S$. Given that the equation is homogenous, which of the following statements must be correct?

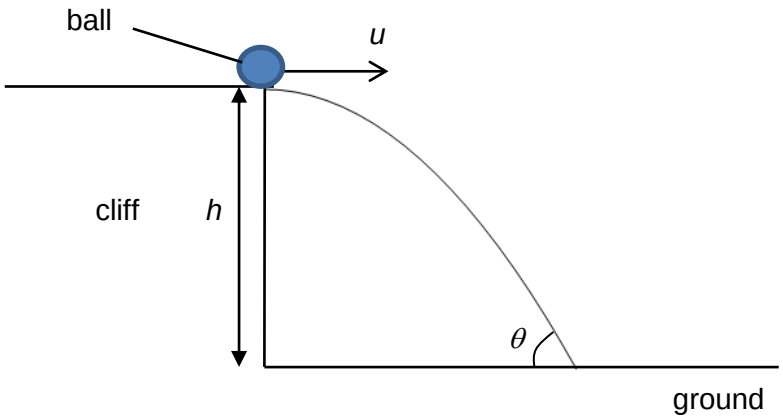
A *P*, *Q*, *R* and *S* all have the same unit.

B P, *Q*, *R* and S are all scalar quantities.

C The product *R S* has the same unit as *P* and *Q.*

D The product *R S* is numerically equal to (*Q* – *P*).

4 A ball is projected horizontally with a speed of u from the cliff as shown. The height of ball released above the ground is h. When the ball strikes the ground, the direction of velocity of the ball makes an angle of θ with the ground.



Which of the following values of u and h will give the highest value of the angle θ?

	h / m	u / m s^{-1}
A	25	10
B	25	25
C	50	10
D	50	25

5 A racing car accelerates uniformly along a straight road. Marker posts are placed at 200 m apart. The car has a speed of 20 m s^{-1} when it passes one post, and speed of 40 m s^{-1} when it passes the next. What is the acceleration of the car?

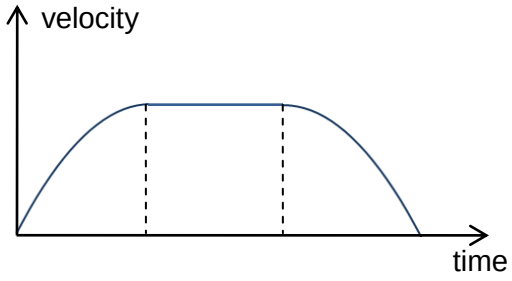
A 1.0 m s^{-2}

B 2.0 m s^{-2}

C 3.0 m s^{-2}

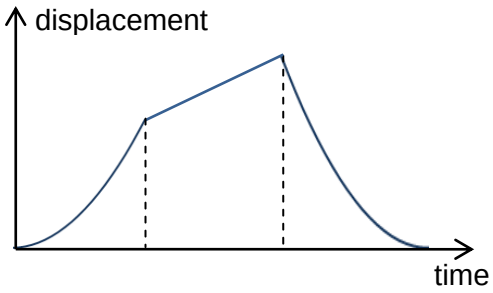
D 4.0 m s^{-2}

6 The graph below shows the variation with time of the velocity of a moving body.

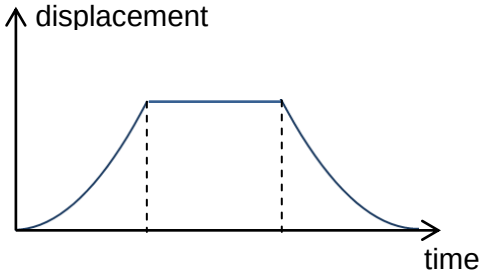


Which of following graph represents the corresponding displacement with time?

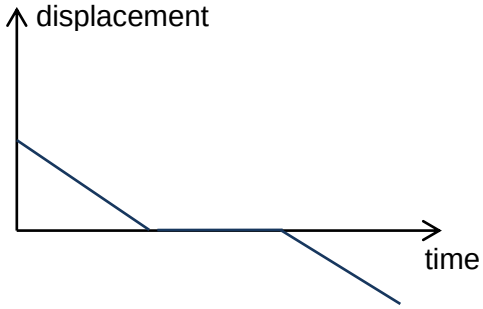
A



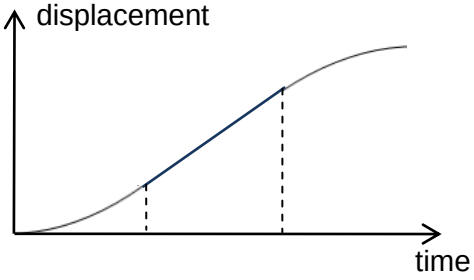
B



C



D



7 Which of the following pairs of forces is **NOT** an example of action and reaction to which Newton's third law of motion applies?

A The centripetal force holding a satellite in orbit round the Earth and the weight of the satellite.

B The forces of repulsion experienced by each of the two parallel wires carrying currents in opposite directions.

C The forces of attraction felt by each of the two molecules passing near to each other.

D The electrostatic forces between an electron and a proton in a hydrogen atom.

8 A pendulum bob hangs from the ceiling in a train carriage and is just above a certain mark on the floor when the train is at rest. When the train is moving forward with constant acceleration, the bob

A moves steadily ahead of the mark because the speed of the train keeps increasing.

B is behind the mark in a position such that the resultant force exerted on the bob by the train is forward.

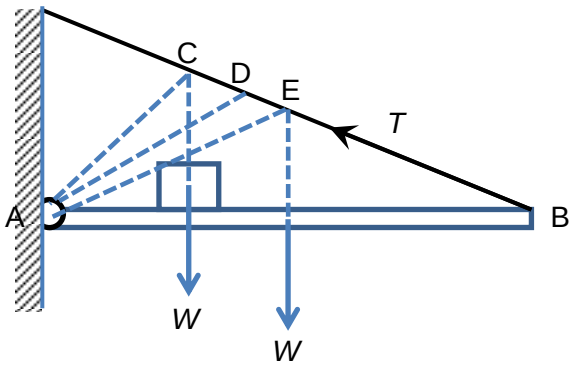
C is ahead of the mark in a position such that the resultant force exerted on the bob by the train is forward.

D remains over the mark because the acceleration is experienced by the train alone.

9 Two bodies P and Q having masses M_p and M_Q respectively, exert forces on each other and have no other forces acting on them. The force acting on P is F, which gives P an acceleration, a. Which of the following pairs correctly shows the magnitude of the force and acceleration experienced by Q?

	Magnitude of force on Q	Magnitude of acceleration of Q
A	$F(M_p / M_Q)$	a
B	$F(M_P / M_Q)$	$a(M_P / M_Q)$
C	F	a
D	F	$a(M_P / M_Q)$

10 A uniform beam of weight W is hinged on one end at A and held by a wire on the other end at B. It carries a load, also of weight W, as shown. The tension in the wire is T.



Which of the following is the most likely direction of the force exerted by the hinge on the beam at A?

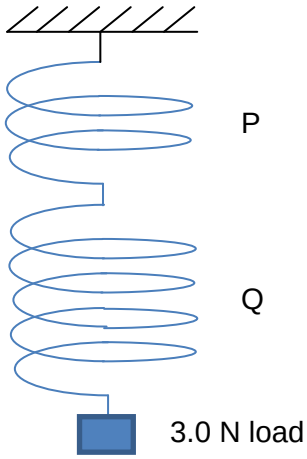
A AB

B AC

C AD

D AE

11 The spring system shown is composed of two springs, P and Q, of negligible mass connected in series. P has a spring constant of 30 N m^{-1} and Q has a spring constant of 10 N m^{-1}.



When a 3.0 N load is supported by the system, which of the following is the overall extension produced?

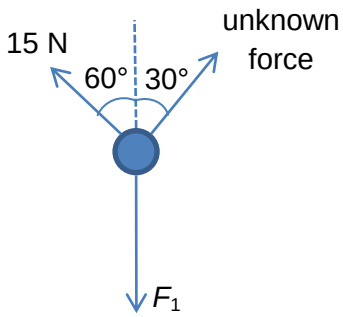
A 40 mm

B 150 mm

C 250 mm

D 400 mm

12 An object is held in equilibrium by 3 forces as shown.



What is the value of F_1?

A 17 N

B 26 N

C 30 N

D 36 N

13 A crane uses an electric motor to lift a load of mass 300 kg up to a height of 15 m in 2.0 min. The motor has an efficiency of 60%. What is the electrical power required?

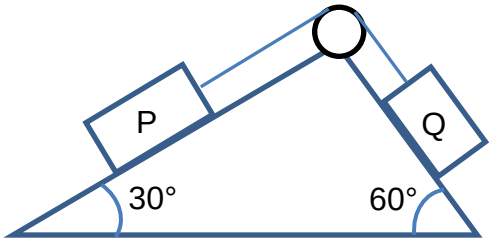
A 0.22 kW

B 0.61 kW

C 1.2 kW

D 63 kW

14 Block P and Q, connected by a light, inextensible cable placed over a pulley, are released from rest. P has a mass of 10.0 kg and Q has a mass of 12.0 kg.



Given that the slope and pulley are frictionless, which of the following is the total kinetic energy of the two blocks after they have been displaced by 1.0 m along the slope?

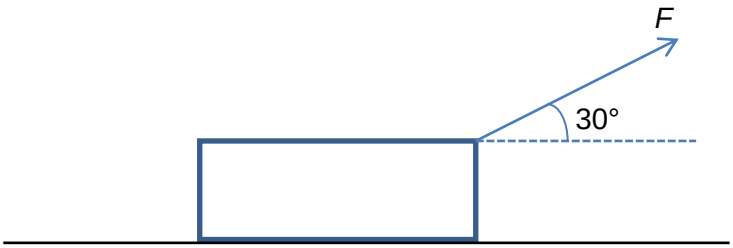
A 49.1 J

B 52.9 J

C 102 J

D 106 J

15 A force, *F* of 20 N is applied at an angle of 30° with respect to the horizontal on a 10 kg crate that slides along a rough horizontal surface at a constant speed. The crate slides over a distance of 8.0 m.



What is the work done by the frictional force exerted by the ground on the crate?

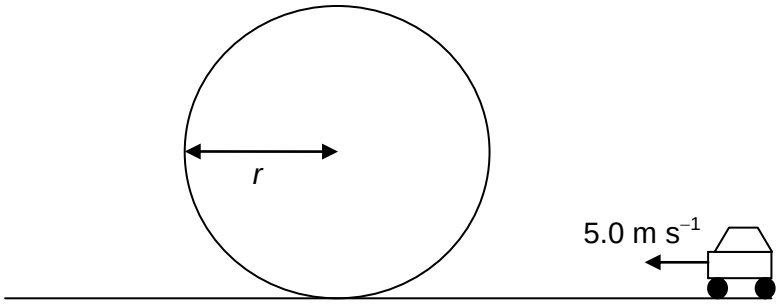
A 0 J

B – 80 J

C – 139 J

D – 160 J

16 John launches his toy car with a speed of 5.0 m s^{-1} towards a vertical circular loop of radius *r*. He repeats the experiment with several other loops of different radii.



What is the maximum radius of the vertical circular loop that the toy car can travel in so that it can complete the loop without falling off the track?

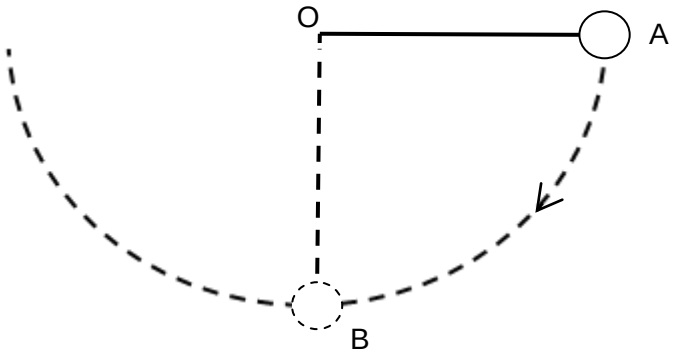
A 0.50 m

B 0.84 m

C 1.2 m

D 2.5 m

17 A mass is suspended from a fixed point O by a light, inextensible cord. The mass is raised to position A where the cord is horizontal. The mass is then released. The path of the mass follows the arc of a circle.



When it passes through its lowest position at point B, the tension in the cord is

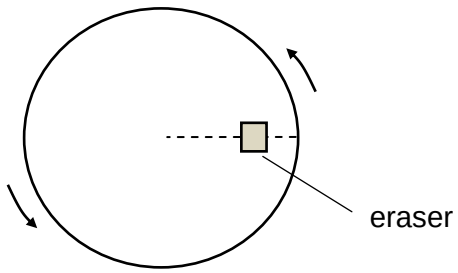
A zero

B *mg*

C 2*mg*

D 3*mg*

18 An eraser is placed on top of a horizontal rotating plate.



Top view

Which of the following statements explains why the eraser remains on the rotating plate moving in a circular path?

A The frictional force acting on the eraser equals to the centripetal force and hence there is no resultant force acting on the eraser.

B The frictional force acting on the eraser is smaller than the centripetal force and hence there is a resultant force directed towards the centre of the circle which is just sufficient to provide the centripetal acceleration of the circular motion.

C The frictional force acting on the eraser is larger than the centripetal force and hence there is a resultant force directed towards the centre of the circle which is just sufficient to provide the centripetal acceleration for the circular motion.

D The frictional force acting on the eraser is the resultant force which is just sufficient to provide the centripetal acceleration for the circular motion.

19 Which of the following statements about geostationary satellites is **false**?

A All geostationary satellites have the same speed.

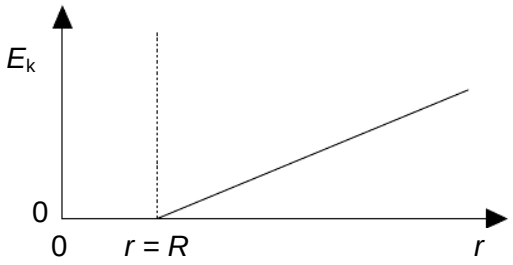
B All geostationary satellites have the same kinetic energy.

C All geostationary satellites have the same radius of orbit.

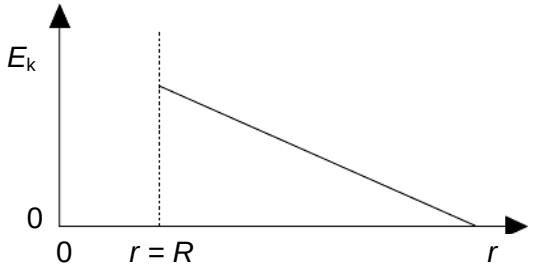
D All geostationary satellites are placed directly above the equator.

20 Which of the following graphs best shows how the kinetic energy E_k of orbiting satellites varies with the distance r from the centre of a planet with radius R?

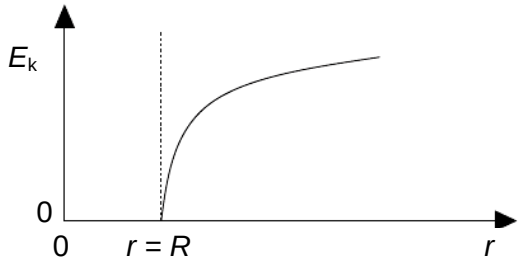
A



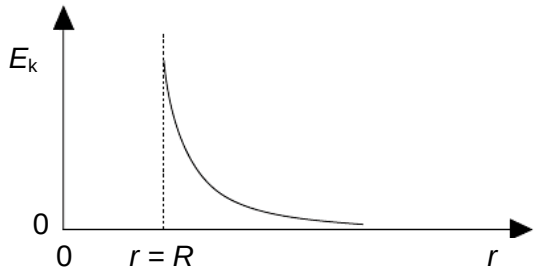
B



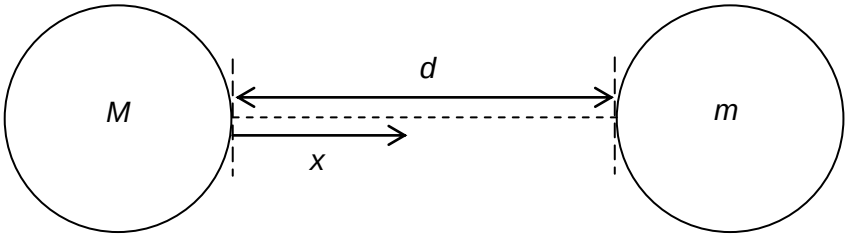
C



D

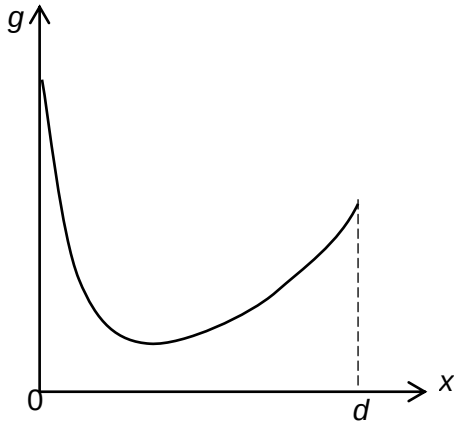


21 Two isolated masses *M* and *m*, of the same radius, are held a distance *d* apart, as shown below. Mass *M* is greater than mass *m*.

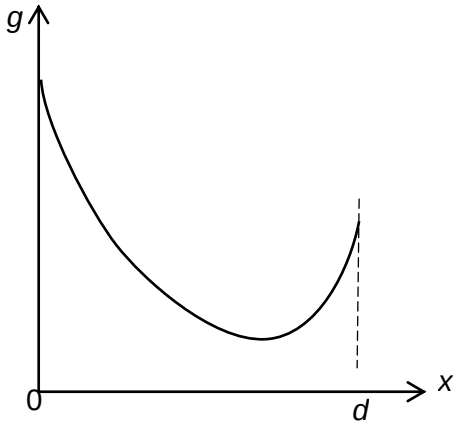


Which of the following best shows the variation with distance *x* of the magnitude of the net gravitational field strength *g*?

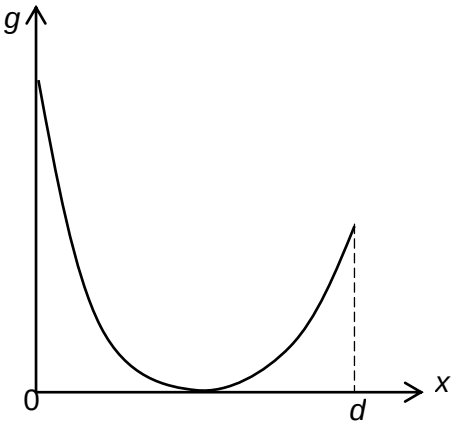
A



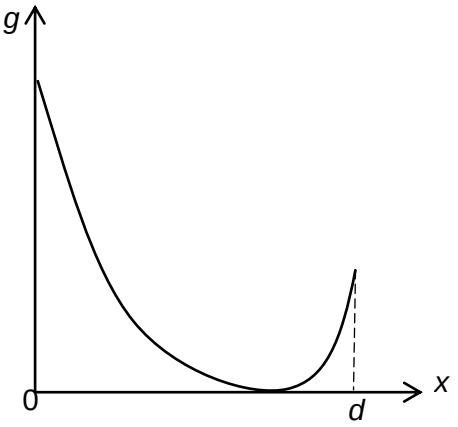
B



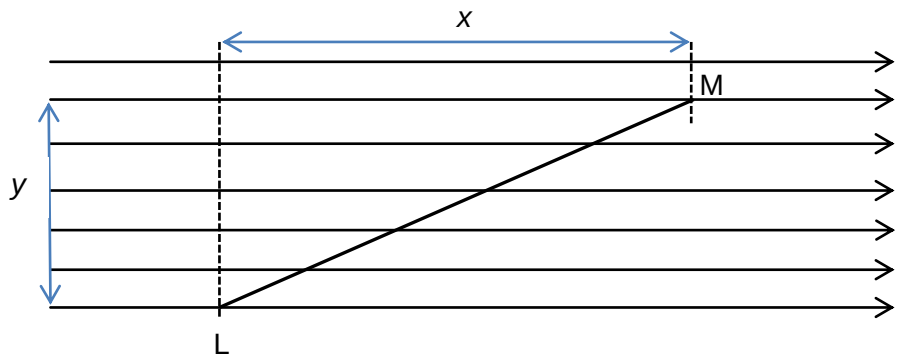
C



D



22 A small positive charge, placed at a point L inside a uniform electric field, experiences a force of magnitude *F*.



The charge is moved from point L to point M. What is the change in electric potential energy of the charge?

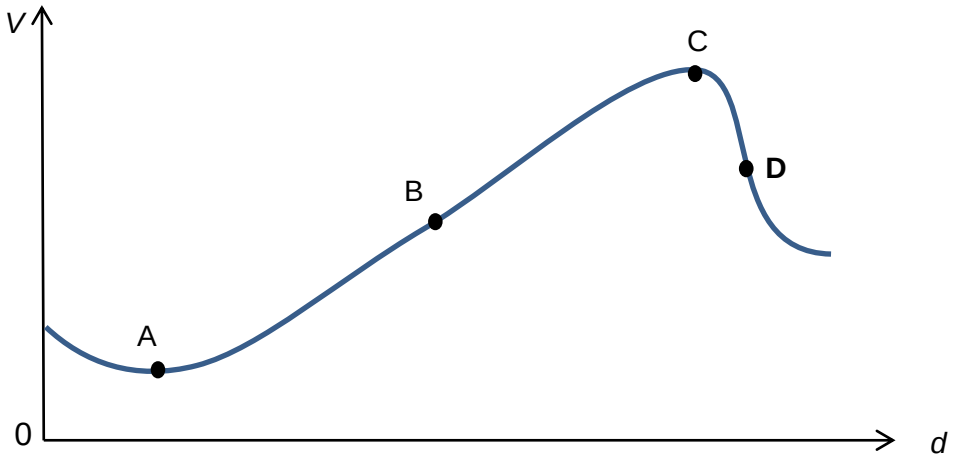
A gain of *Fx*

B loss of *Fx*

C gain of *Fy*

D loss of $F\sqrt{x^2+y^2}$

23 The diagram shows the variation of the electric potential *V* with distance *d* along a straight line in an electric field. At which point is the magnitude of the electric field strength greatest?



24 In discussing electric fields, the terms ‘electric field strength’, ‘electric potential’ and ‘potential gradient’ are used.

Which statement about these terms is correct?

A Electric field strength at a point is the force per unit positive charge on a stationary charge in the field.

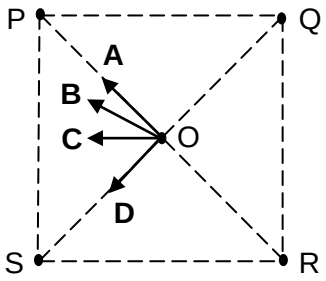
B Electric potential and potential gradient are both scalar quantities.

C The potential gradient at a point is numerically equal to the electric potential energy at that point.

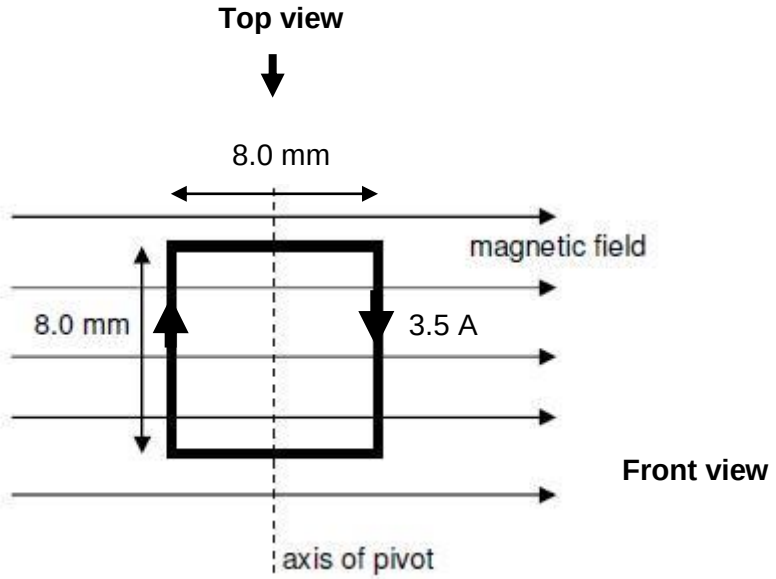
D Electric force is the force on a charge and the charge must be positive.

25 The figure below shows four long, straight current-carrying wires P, Q, R and S. which are perpendicular to the plane of the paper. They pass through the corners of a square. Point O is the point of intersection of the diagonals of the square. The magnitude of current in wire P is twice the magnitude of currents in the other three wires. The currents in wires P, Q and R flow into the plane of the paper while that in S flows out of the plane of the paper.

Which arrow best shows the direction of the resultant magnetic field at O?



26 A 15-turn square coil of side 8.0 mm is placed in a uniform magnetic field of flux density 0.050 T such that two sides of the coil are parallel to the field and two sides are perpendicular to the field, as shown below. A current of 3.5 A is passed through the coil so that it rotates about the axis of pivot as shown.



What is the magnitude and direction (when viewed from the top) of the torque acting on the square coil?

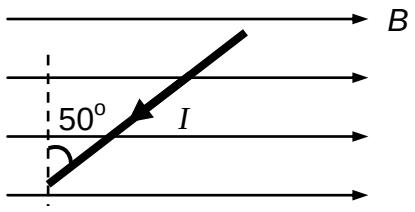
A 1.7×10^{-4} N m; clockwise

B 1.7×10^{-4} N m; anti-clockwise

C 2.1×10^{-2} N m; clockwise

D 2.1×10^{-2} N m; anti-clockwise

27 A current I of 2.8 A passes through a conductor of length 1.4 m placed in a uniform magnetic field *B* of strength 5.0 T.



What is the magnitude and direction of the magnetic force acting on the conductor?

A 13 N; INTO plane

B 13 N; OUT of plane

C 15 N; INTO plane

D 15 N; OUT of plane

28 A piece of cylindrical copper wire with resistivity ρ has resistance R. A second piece of cylindrical wire, made of a different material, has half the length and double the diameter of the copper wire, but has the same resistance R. What is the resistivity of the second wire?

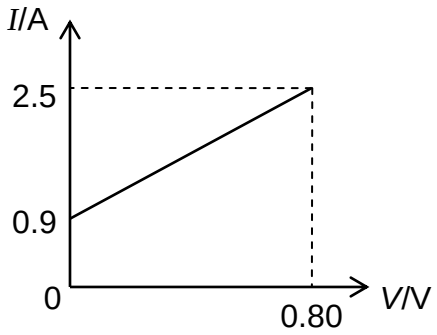
A ρ

B 2ρ

C 4ρ

D 8ρ

29 The following graph shows the variation with the potential difference V of the current I flowing through a conductor.



Which of the following statements best describes the resistance of the conductor?

A The resistance is constant with a value of 2.0 Ω.

B The resistance is constant with a value of 0.5 Ω.

C The resistance increases as V increases.

D The resistance decreases as V increases.

30 An electric kettle is rated at 4.00 kW when operating on a 240 V supply. If the supply is reduced to 120 V, what is the new output power of the kettle?

A 0.50 kW

B 1.00 kW

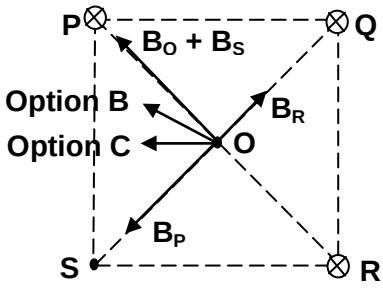
C 2.00 kW

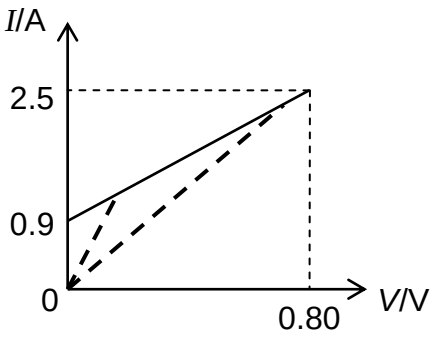
D 4.00 kW

Question	Explanation	Correct answer
1	$[\eta] = \frac{N\,m^{-3}m^2}{m\,s^{-1}} = N\,m^{-2}\,s$	**B**
2		**D**
3	Option D may not be true as a homogenous equation may not mean that the equation is correct. Hence product of RS may not be numerically equal to (Q - P).	**C**
4	Angle θ will be the largest when v_y is the largest and v_x is the smallest. v_y will be largest when the height that the object falls through is the largest since it allow more time for the acceleration to take place. The largest height with the smallest v_x hence would give rise to the largest θ.	**C**
5	$v^2 = u^2 + 2as$ $40^2 = 20^2 + 2(a)(200)$ $a = 3.0\ m\ s^{-2}$	**C**
6	Value of the v-t gives the slope of the displacement time. The value of v-t is positive vlaue, increases, remains the same and then decreases. The slope of displacement-time hence is a positive slope and it becomes steeper folllows by a constant slope and lastly a decreasing.	**D**
7	Centripetal force is a resultant force and not a real force. The action and reaction pair with the weight of the satellite should be the gravitational force of attraction of the Earth by the satellite.	**A**
8	The bob should be behind the mark so that the horizontal component of the tension is the resultant force which provides the forward acceleration of bob.	**B**
9	$F_{P\ on\ Q} = F_{Q\ on\ P}$ (action and reaction pair) $M_Q a_Q = M_P a_P$ $a_Q = \frac{M_P}{M_Q} a_P$	**D**
10	For option A, taking moments about B, there will be a resultant anticlockwise moment due to the two weights. For option B, taking amoments about C, there will be a resultant clockwise moment due to the weight of the beam.	**C**

	For option C, taking moments about D, the clockwise moment due to the weight of the beam equals to the anticlockwise moment due to the weight of the mass. For option D, taking moments about E, there will be a resultant anticlockwise moment due to the weight of the mass.	
11	Extension P = F / k_P = 3.0 / 30 = 0.10 m Extension Q = F / k_Q = 3.0 / 10 = 0.30 m Total extension = 0.40 m = 400 mm	**D**
12	Let unknown force be F_2 $\Sigma F_x = 0$ 15 sin60 = F_2 sin30 F_2 = 25.98 N $\Sigma F_y = 0$ F_1 = 15 cos60 + 25.98 cos30 F_1 = 30 N	**C**
13	WD = F x d = 300(9.81)(15) = 44145J Power output = WD/t = 44145/(2x60) = 367.9W Power input = Power output x 100% / efficiency = 367.9 x 100% / 60 = 613 W = 0.61 kW	**B**
14	Gain in KE of system = Loss in GPE of system Gain in KE = 12(9.81)(1 sin60) – 10(9.81)(1 sin30) = 52.9 J	**B**
15	WD by friction = (20)(8.0)(cos 150) = – 139 J	**C**
16	At the top, $\Sigma F = mv_{top}^2 / r$ $mg + N = mv_{top}^2 / r$ $N = mv_{top}^2 / r - mg$ N > 0 $mv_{top}^2 / r - mg > 0$ $v_{top}^2 > rg$ ---------- (1) ½ mv_{bottom}^2 = ½ mv_{top}^2 + mgh $v_{top}^2 = v_{bottom}^2 - 2g(2r)$ ---------- (2) $v_{bottom}^2 - 2g(2r) > rg$ ---------- (1) & (2) $5rg < v_{bottom}^2$ r < 0.50 (round down) Option B (students who substituted *r* instead of 2*r* into *h*) Option D (students who simply substituted 5.0 m s^{-1} into v_{top} to get the maximum r)	**A**

17	KE of mass at B = mg(r) = ½ mv_B^2 $v_B^2 = 2rg$ ---------- (1) At the bottom, $\Sigma F = mv_B^2/r$ $T - mg = mv_B^2/r$ ---------- (2) $T - mg = 2mg$ ---------- (1) & (2) $T = 3mg$ Option B (students have used $mg - T = mv_B^2/r$ instead)	**D**
18	**D** Centripetal force is a resultant force and should not be compared like it is a real force. Option B (Frictional force is not smaller than the centripetal force) Option C (Frictional force is not larger than the centripetal force)	**D**
19	**B** They have the same ω and same r, hence they have the same speed. However, they have different kinetic energy which is dependent on the mass of the satellite.	**B**
20	$E_k = GMm/2r$ Hence $E_k \alpha 1/r$	**D**
21	The graph will touch the x-axis as there is a neutral point where the net g field will be zero. The neutral point will be closer to the smaller mass.	**D**
22	Potential at M is lower than the potential at L. Since potential energy = potential at the point x charge, and that the charge is a positive charge, there is a loss in the potential energy. Change in potential energy is due to work done by the electric field. Since the electric force experienced by the charge is constant, WD = F x distance in the direction of the force = Fx Therefore there is a loss of Fx.	**B**
23	$E = \frac{-dV}{dr}$ Magnitude of *E* is the largest when $\frac{dV}{dr}$ is the largest. D has the steepest gradient.	**D**

24	Option B is incorrect as potential gradient is the electric field which is a vector quantity. Option C is incorrect as the potential gradient is numerically equal to the magnitude of the electric field strength instead. Option D is incorrect as the charge need not be a positive charge.	**A**
25	Use right hand grip rule on each of the wires. Since B α I, B_P at O is twice the strength compared to the magnetic field strength due to the other wires.  Due to the presence of B_R, the magnetic field in the OS direction is half of B_P, hence the resultant is in the direction of option B instead of option C.	**B**
26	Torque = NBIL x $\perp$ distance between the two forces = (15)(0.050)(3.5)(0.008) x (0.008) = 1.7 x 10^{-4} N m	**A**
27	F = BILsinθ = (5.0)(2.8)(1.4)(sin40) = 12.6 = 13 N Note that θ is the angle between the B and I. Direction : using Fleming's left hand rule	**B**
28	$R = \frac{\rho l}{\pi\left(\frac{d}{2}\right)^2}$ $R_1 = \frac{\rho_1 l_1}{\pi\left(\frac{d_1}{2}\right)^2}$ $\quad$ $R_2 = \frac{\rho_2\left(\frac{1}{2}l_1\right)}{\pi\left(\frac{2\times d_1}{2}\right)^2} = \frac{\frac{1}{2}\rho_2 l_1}{4\pi\left(\frac{d_1}{2}\right)^2}$ $R_2 = R_1$ $\rho_2 = 8\rho_1$	**D**

29	Note that the resistance is not the gradient of the line. $R \neq dV/dI$ & $R \neq dI/dV$. Instead, it is the V-I ratio at that particular point.  By drawing lines from origin to the graph, the I-V ratio (gradient of the dotted lines drawn) becomes smaller as V increases. Hence V-I ratio becomes bigger as V increases. Since R = V/I (which is V-I ratio), the resistance is larger as V increases.	**C**
30	$P_{240V} = \frac{V^2}{R}$ $4000 = 240^2 / R$ $R = 14.4\ \Omega$ $P_{120V} = \frac{V^2}{R}$ $= 120^2 / 14.4 = 1.00$ kW	**B**