MATHEMATICS QUESTIONS BY TOPICS

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MOTION AND FORCE

50 Multiple Choice Questions with detailed answers

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Mathematics Questions by Topics
Motion and Force – Multiple Choice

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Mathematics Questions by Topics
Motion and Force Question 1 Source: K22SM2Q14

Question 1

Two masses of mass *m* and 2*m* kg are hanging vertically and connected by a light string which passes over a smooth pulley. In this situation the mass $2m$ moves downwards with an acceleration of a $\text{ms}^{-2}$and the tension in the string is T_1 newtons. When an extra mass of 3*m* is added to the mass *m*, it now moves down with the same acceleration of a ms^{-2} and the tension in the string is T_2 newtons. The ratio $\frac{T_2}{T_1}$ is equal to.

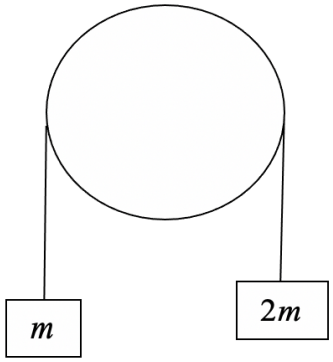
A. $\frac{1}{3}$

B. 1

C. 2

D. 3

E. 4



Mathematics Questions by Topics
Motion and Force Question 2 Source: K22SM2Q17

Question 2

A particle of mass *m* kg slides from rest down a smooth inclined plane, and travels a distance of *S* metres down the plane in a time of T_1 seconds. Another particle of mass 2*m* kg is placed on the same plane and travels a distance of 2*S* metres down the plane in a time of T_2, seconds, then

A. $T_2 = 4T_1$

B. $T_2 = 2T_1$

C. $T_2 = T_1$

D. $T_2 = \frac{T_1}{2}$

E. $T_2 = \sqrt{2}\,T_1$

Mathematics Questions by Topics
Motion and Force Question 3 Source: K21SM2Q12

Question 3

A particle of mass 5 kg is on a rough horizontal plane. The particle is acted upon up by a force of T newtons acting at an angle of 60^0 to the plane. A frictional force of $\frac{49\sqrt{3}}{3}$ newtons acting parallel to the plane, opposes the motion. Then if

A. $T = \frac{98\sqrt{3}+30}{3}$ the particle moves along the plane with an acceleration of $1\ \text{ms}^{-2}$.

B. $T = \frac{98\sqrt{3}-30}{3}$ the particle moves along the plane with an acceleration of $1\ \text{ms}^{-2}$.

C. $T = \frac{98\sqrt{3}+60}{3}$ the particle moves along the plane with an acceleration of $2\ \text{ms}^{-2}$.

D. $T = \frac{98\sqrt{3}-60}{3}$ the particle moves along the plane with an acceleration of $2\ \text{ms}^{-2}$.

E. $T < \frac{98\sqrt{3}}{3}$ the particle does not move.

Mathematics Questions by Topics
Motion and Force Question 4 Source: K21SM2Q15

Question 4

A particle of mass 2 kg, is moving so that its velocity vector at a time *t*, given by $\dot{\underset{\sim}{r}}(t) = 4\sin^2(t)\underset{\sim}{i} + 4\cos^2(t)\underset{\sim}{j}$, for $t \geq 0$, given that $\underset{\sim}{r}\left(\frac{\pi}{4}\right) = \frac{\pi}{2}\left(\underset{\sim}{i} + \underset{\sim}{j}\right)$

The change in momentum over $\frac{\pi}{6} \leq t \leq \frac{\pi}{4}$, is given by

A. $-2\underset{\sim}{i} + 2\underset{\sim}{j}$.

B. $2\underset{\sim}{i} - 2\underset{\sim}{j}$.

C. $\underset{\sim}{i} - \underset{\sim}{j}$

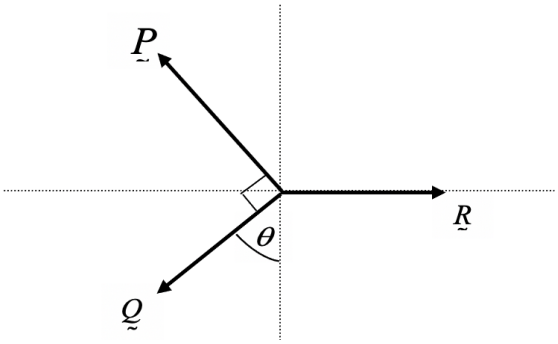
D. $-\underset{\sim}{i} + \underset{\sim}{j}$

E. $2\sqrt{2}$

Mathematics Questions by Topics
Motion and Force Question 5 Source: K20SM2Q10

Question 5

The following diagram shows a particle in equilibrium under the action of three concurrent coplanar forces $\underset{\sim}{P}$, $\underset{\sim}{Q}$ and $\underset{\sim}{R}$. The forces, $\underset{\sim}{P}$, $\underset{\sim}{Q}$ and $\underset{\sim}{R}$ have magnitudes of P, Q and R respectively.



Which one of the following statements is **not** correct?

A. $P\sec(\theta)=Q\operatorname{cosec}(\theta)$

B. $\cot(\theta)=\dfrac{P}{Q}$

C. $R=Q\sin(\theta)+P\cos(\theta)$

D. $R^2=P^2+Q^2$

E. $P+Q+R=0$

Mathematics Questions by Topics
Motion and Force Question 6 Source: K20SM2Q19

Question 6

A body is moving in a straight line. When its displacement is *x* metres from the origin at time *t* seconds, $t = x\cos(2x)$. The acceleration in ms^{-2} is given by

A. $\dfrac{-2\sin(2x)}{\cos^3(2x)}$

B. $\dfrac{4(\sin(2x)+x\cos(2x))}{(\cos(2x)-2x\sin(2x))^3}$

C. $\dfrac{4(\sin(2x)+x\cos(2x))}{(\cos(2x)-2x\sin(2x))^2}$

D. $\dfrac{1}{\cos(2x)-2x\sin(2x)}$

E. $-4(x\cos(2x)+2\sin(2x))$

Mathematics Questions by Topics
Motion and Force Question 7 Source: K20SM2Q20

Question 7

A particle of mass *m* kg falls vertically downwards, from rest in a medium which offers air resistance equal to kv^2 newtons, where v ms^{-1} is its velocity at a time *t* seconds. After a time *T* seconds, its velocity is V ms^{-1} and it has travelled a distance of *D* metres.
Which of the following is **false**?

A. $m\dfrac{dv}{dt} = mg - kv^2$

B. $D = \displaystyle\int_0^V \frac{mv}{mg - kv^2}\,dv$

C. $V = \dfrac{D}{T}$

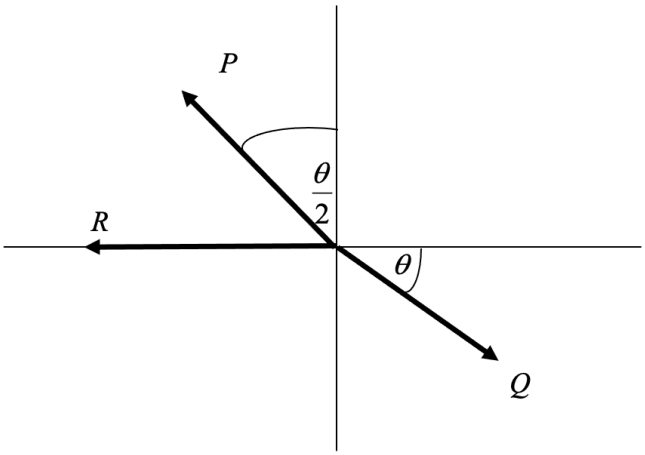
D. $T = \displaystyle\int_0^V \frac{m}{mg - kv^2}\,dv$

E. Its limiting or terminal velocity is equal to $\sqrt{\dfrac{mg}{k}}$ ms^{-1}.

Mathematics Questions by Topics
Motion and Force Question 8 Source: K19SM2Q12

Question 8

Three coplanar forces of magnitudes *P*, *Q* and *R* newtons act on a particle that is in equilibrium as shown in the diagram below.



Then,

A. $P\sin\left(\frac{\theta}{2}\right)=Q\cos(\theta)$

B. $P\cos\left(\frac{\theta}{2}\right)+R=Q\sin(\theta)$

C. $P=Q\sin\left(\frac{\theta}{2}\right)$

D. $P=2Q\sin\left(\frac{\theta}{2}\right)$

E. $P+Q+R=0$

Mathematics Questions by Topics
Motion and Force Question 9 Source: K19SM2Q14

Question 9

A particle of mass 3 kg travels in a straight line with velocity v ms^{-1} when its displacement is *x* metres, where $v = \sqrt{4x^2 + 9}$. The force in newtons acting on the particle when $x = 2$ is

A. 24

B. 12

C. 8

D. 4

E. $\frac{24}{5}$

Mathematics Questions by Topics
Motion and Force Question 10 Source: K19SM2Q17

Question 10

An object of mass 10 kg is initially at rest on a rough plane inclined at an angle of 30^0 to the horizontal. The object is pulled up the plane by a force of 75 N acting up and parallel to the plane. A frictional force of 11 N acting parallel to the plane, opposes the motion. After the pulling force has acted for 2 seconds, the magnitude of the momentum of the particle in kg ms^{-1} is closest to

A. 10

B. 20

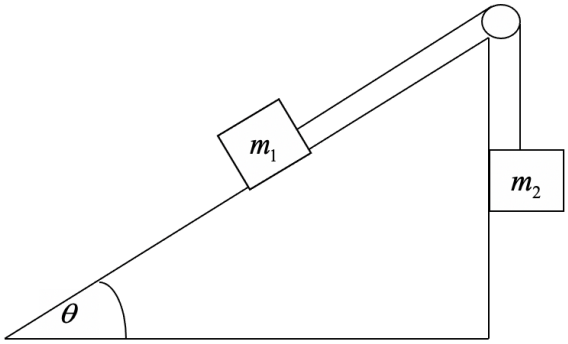
C. 30

D. 40

E. 50

Mathematics Questions by Topics
Motion and Force Question 11 Source: K18SM2Q15

Question 11
A particle of mass m_1 kg is on a smooth plane, inclined at an angle of θ to the horizontal. It is connected by a light string which passes around a smooth pulley to another mass of m_2 kg hanging vertically, as shown in the diagram.



Then which of the following is **false?**

A. If $\theta = 30^0$ and $\frac{m_2}{m_1} = \frac{1}{2}$ then the system is in equilibrium.

B. If $\theta = 30^0$ and $\frac{m_2}{m_1} < \frac{1}{2}$ then the mass m_2 moves upwards.

C. If $\theta = 45^0$ and $\frac{m_2}{m_1} = \frac{\sqrt{2}}{2}$ then the system is in equilibrium.

D. If $\theta = 60^0$ and $\frac{m_2}{m_1} = \frac{\sqrt{3}}{2}$ then the system is in equilibrium.

E. If $\theta = 60^0$ and $\frac{m_2}{m_1} < \frac{\sqrt{3}}{2}$ then the mass m_2 moves downwards.

Mathematics Questions by Topics
Motion and Force Question 12 Source: K18SM2Q16

Question 12
A body is moving in a straight line. When its displacement is *x* metres from the origin at time *t* seconds, then $t = e^{kx}$, where *k* is a non-zero constant. The acceleration in ms^{-2} is given by

A. $-e^{-kx}$

B. $-\dfrac{e^{-kx}}{k^2}$

C. $-\dfrac{e^{-2kx}}{k}$

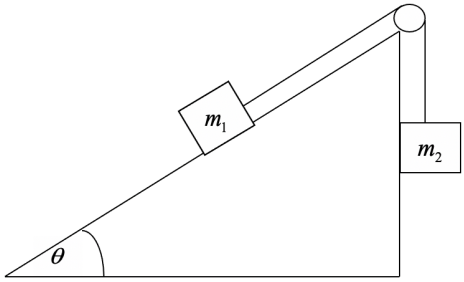
D. $-k$

E. e^{-2kx}

Mathematics Questions by Topics
Motion and Force Question 13 Source: K17SM2Q13

Question 13

A particle of mass m_1 kg is on a smooth plane, inclined at an angle of θ to the horizontal. It is connected by a light string which passes around a smooth pulley to another mass of m_2 kg hanging vertically, as shown in the diagram.



Which of the following is **false?**

A. The tension in the string is equal to $\dfrac{m_1 m_2\left(1+\sin\left(\theta\right)\right)}{m_1+m_2}$ kg-wt.

B. If $m_2 > m_1\sin\left(\theta\right)$ the mass m_2 moves downwards with an acceleration $\dfrac{g\left(m_2 - m_1\sin\left(\theta\right)\right)}{m_1+m_2}$ ms^{-2}.

C. If $m_2 = m_1\sin\left(\theta\right)$ the masses remain at rest.

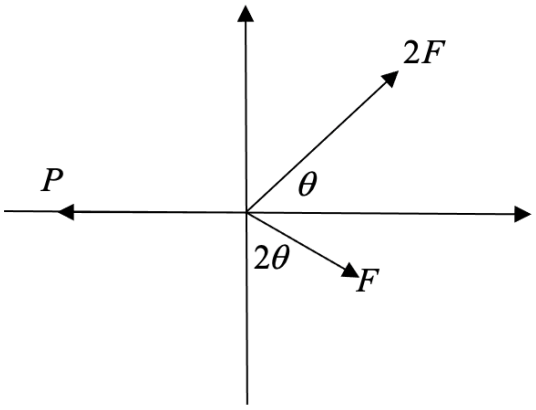
D. If $m_2 = 2m_1$ and $\theta = 30^0$ the tension in the string is $\dfrac{g}{2}$ newtons.

E. If $m_2 = 2m_1$ and $\theta = 30^0$ the mass m_2 moves downwards with an acceleration $\dfrac{g}{2}$ ms^{-2}.

Mathematics Questions by Topics
Motion and Force Question 14 Source: K16SM2Q17

Question 14

A body is on a horizontal smooth plane and acted upon by three forces, with magnitudes and directions as shown in the diagram below.



The correct statement relating the magnitude of the forces and the angle θ is

A. $P = 3F$

B. $P = 3F\sin(3\theta)$

C. $P = 3F\cos(3\theta)$

D. $P = 2F\sin(\theta) + F\cos(2\theta)$

E. $\theta = \sin^{-1}\left(\frac{\sqrt{3}-1}{2}\right)$

Mathematics Questions by Topics
Motion and Force Question 15 Source: K15SM2Q15

Question 15

The position vector of a 2 kg moving particle is given by $\underset{\sim}{r}(t) = 4\sin(t)\underset{\sim}{i} + \cos(2t)\underset{\sim}{j}$ where the position in measured in metres and $t \geq 0$ is the time in seconds. The maximum momentum in kg-m/s of the particle is

A. 8

B. 4

C. 2

D. 1

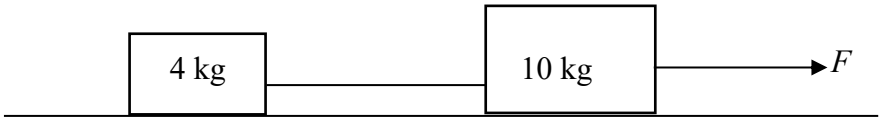
E. $2\sqrt{5}$

Mathematics Questions by Topics
Motion and Force Question 16 Source: K15SM2Q16

Question 16

Two boxes of masses 10 kg and 4 kg are connected by a light horizontal string and are on a horizontal table, as shown in the diagram below. The coefficient of friction between the 10 kg box and the table is 0.5.The contact between the 4 kg block and table is smooth. The 10 kg box is pulled by a force of F, parallel to the table.

Which of the following is **false?**



A. If $F = 50$ newtons, the boxes move with a constant acceleration equal to $\frac{1}{14}$ m/s^2

B. If $F = 49$ newtons, the boxes are on the point of moving.

C. If $F = 48$ newtons, the boxes move with constant velocity.

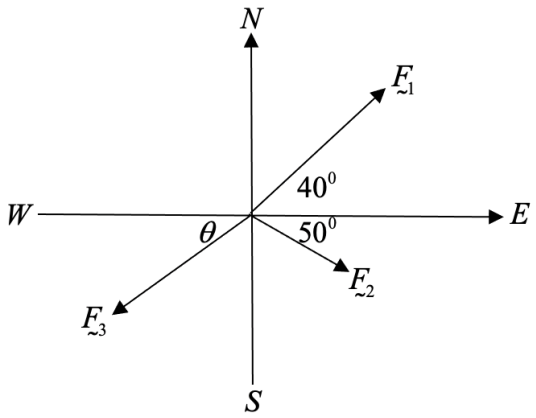
D. If $F = 47$ newtons the boxes remain at rest.

E. If $F = 46$ newtons

Mathematics Questions by Topics
Motion and Force Question 17 Source: K15SM2Q17

Question 17

A body is on a horizontal smooth plane and acted upon by three forces, $\underset{\sim}{F}_1, \underset{\sim}{F}_2$ and $\underset{\sim}{F}_3$.
A north-south west-east framework is shown.



Given that $|\underset{\sim}{F}_1| = 10$, $|\underset{\sim}{F}_2| = 5$ and let $F_3 = |\underset{\sim}{F}_3|$ and that the body moves in the north direction, then

A. $F_3\cos(\theta) = 10.874$ and $F_3\sin(\theta) > 2.598$

B. $F_3\cos(\theta) = 10.874$ and $F_3\sin(\theta) < 2.598$

C. $F_3\sin(\theta) = 2.598$ and $F_3\sin(\theta) < 10.874$

D. $F_3\sin(\theta) = 10.874$ and $F_3\cos(\theta) > 2.598$

E. $F_3\sin(\theta) = 10.874$ and $F_3\cos(\theta) < 2.598$

Mathematics Questions by Topics
Motion and Force Question 18 Source: K14SM2Q18

Question 18

A car is moving with constant acceleration has its speed reduced from $3V$ ms^{-1} to V ms^{-1}, over a distance of D m when the driver applies the brakes. The car travels a further distance of S m until it comes to rest. The time T seconds represents the time when the driver applies the brakes until the car comes to rest. Then

A. $D = 8S$ and $T = \dfrac{2(D+S)}{3V}$

B. $D = 4S$ and $T = \dfrac{2(D+S)}{3V}$

C. $D = 8S$ and $T = \dfrac{S}{V}$

D. $D = 4S$ and $T = \dfrac{S}{V}$

E. $D = 2S$ and $T = \dfrac{D}{2V}$

Mathematics Questions by Topics
Motion and Force Question 19 Source: K14SM2Q19

Question 19

A particle of mass M kg is on a horizontal table and is connected by a light string to a particle of mass 2 kg hanging vertically at the edge of the table. The coefficient of friction between the table and the mass M is equal to $\frac{1}{3}$. Then if

A. $M > 6$ both masses move with constant acceleration.

B. $0 < M < 6$ both masses move with constant acceleration.

C. $0 < M \leq 6$ the system is in limiting equilibrium.

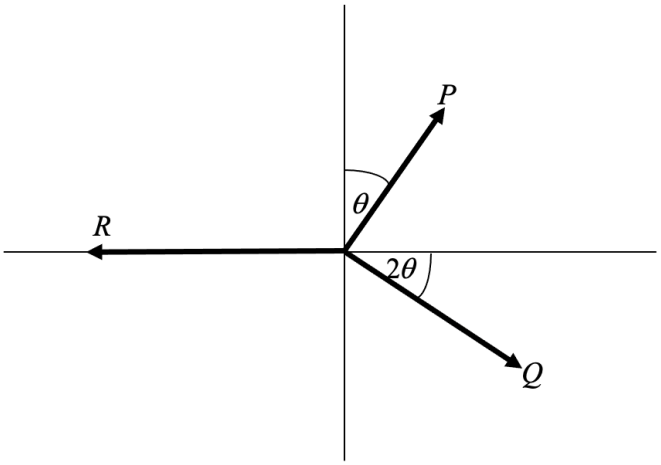
D. $M > 6$ both masses move with constant velocity.

E. $0 < M < 6$ both masses move with constant velocity.

Mathematics Questions by Topic
Motion and Force Question 20 Source: K14SM2Q20

Question 20

Three coplanar forces of magnitudes *P*, *Q* and *R* newtons act on a particle that is in equilibrium as shown in the diagram below.



Then,

A. $Q = R$ and $P = 2R\sin(\theta)$

B. $Q = R$ and $P = 2R\cos(\theta)$

C. $Q = 2P$ and $R = P\sin(\theta)$

D. $P = Q$ and $R = 2P\sin(\theta)$

E. $P + Q + R = 0$

Mathematics Questions by Topics
Motion and Force Question 21 Source: K14SM2Q21

Question 21
A particle of mass 10 kg travels in a straight line with velocity $v \text{ ms}^{-1}$ when its displacement is *x* metres, where $v = 2\log_e\left(\sqrt{x^2+1}+x\right)$ for $x \geq 0$. The maximum force in newtons acting on the particle is closest to

A. 1.5

B. 2.7

C. 20

D. 24

E. 26.5

Mathematics Questions by Topics
Motion and Force Question 22 Source: K13SM2Q11

Question 22

A particle is acted upon by two forces. One has a magnitude of $\sqrt{2}b$ newtons and acts in the direction $S45^0E$, the other has a magnitude of $\sqrt{2}c$ newtons and acts in the direction $N45^0E$, where *b* and *c* are non-zero real positive constants. The magnitude of the resultant force is equal to

A. $\sqrt{2}(b+c)$

B. $\frac{\sqrt{2}}{2}(b+c)$

C. $2\sqrt{2(b^2+c^2)}$

D. $\sqrt{2(b^2+c^2)}$

E. $2\sqrt{b^2+c^2}$

Mathematics Questions by Topics
Motion and Force Question 23 Source: K13SM2Q12

Question 23

A car of mass *m* kg is travelling on a level roadway. The engine exerts a constant propulsive force of *F* newtons and the total resistance to the motion of the car is kv newtons, where *k* is positive constant and *v* is its speed in m/s. The car moves from rest, and travels a distance of *D* metres until it obtains a speed of *V* m/s, in a time of *T* seconds.

Five students stated some relationships between the constants, *m*, *V*, *k*, *F* , *D* and *T*.

Alan stated that $mV = (F - kV)T$ Ben stated that $2mD = (F - kV)T^2$

Colin stated that $\frac{1}{2}mV^2 = (F - kV)D$ David stated that $D = \int_0^V \frac{mv}{F - kv}dv$

Edward stated that $T = \int_0^V \frac{m}{F - kv}dv$

Then

A. Alan, Ben and Colin are all correct.

B. Alan and Colin are both correct.

C. Only Colin is correct.

D. David and Edward are both correct.

E. Only Edward is correct.

Mathematics Questions by Topics
Motion and Force Question 24 Source: K13SM2Q13

Question 24

A girl of mass 50 kg is standing in a lift. The reaction of the lift floor on the girl is equal to 60 kg-wt. Then the lift is moving

A. with constant speed.

B. down with an acceleration equal to 1.96 ms^{-2}.

C. up with an acceleration equal to 1.96 ms^{-2}.

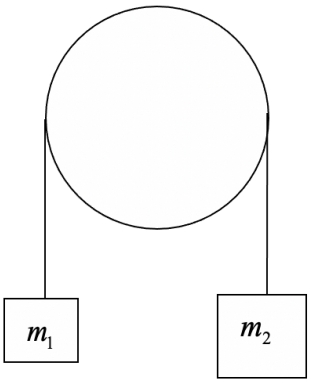
D. down with an acceleration equal to 0.2 ms^{-2}.

E. up with an acceleration equal to 0.2 ms^{-2}.

Mathematics Questions by Topics
Motion and Force Question 25 Source: K13SM2Q21

Question 25

A light inextensible string passes over a smooth pulley, with particles of masses m_1 and m_2 kg, attached to each end of the string as shown in the diagram.



Which of the following is **false?**

A. If $m_2 = 2m_1$ the mass m_2 moves downwards with an acceleration $\frac{g}{2}$ ms^{-2}.

B. If $m_1 = m_2 = m$ the tension in the string is equal to mg newtons.

C. If $m_1 = m_2$ both masses remain at rest.

D. If $m_2 > m_1$ the mass m_2 moves downwards with an acceleration $\frac{(m_2 - m_1)g}{m_1 + m_2}$ ms^{-2}.

E. If $m_1 \neq m_2$ the tension in the string is equal to $\frac{2m_1m_2}{m_1 + m_2}$ kg-wt.

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Mathematics Questions by Topics
Motion and Force Question 26 Source: K13SM2Q22

Question 26

A particle of mass *m* kg is acted upon by a variable force, so that its velocity *v* m/s when the particle is *x* m from the origin is given by $v = e^{cx}$, where *c* is a non-zero real constant. The force acting on the particle when $x = \frac{1}{c}$, in newtons, is

A. mc^2

B. mec

C. me

D. me^2

E. mce^2

Mathematics Questions by Topics
Motion and Force Question 27 Source: K12SM2Q14

Question 27

A body moves in a straight line such that its velocity $v \text{ ms}^{-1}$ is given by $v(x) = e^{2x} - e^{-2x}$, where *x* metres is its displacement from the origin. The acceleration of the body in ms^{-2} is given by

A. $4\left(e^{4x} - e^{-4x}\right)$

B. $2\left(e^{4x} - e^{-4x}\right)$

C. $e^{4x} - e^{-4x}$

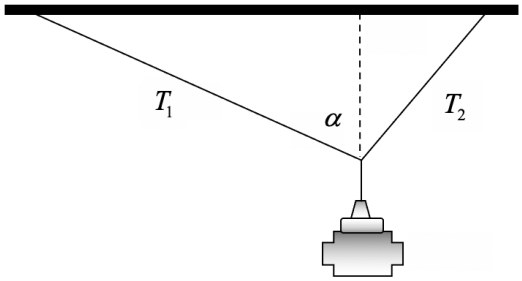
D. $2\left(e^{2x} + e^{-2x}\right)$

E. $-4x$

Mathematics Questions by Topics
Motion and Force Question 28 Source: K12SM2Q17

Question 28

An engine weighing 5 kg is suspended by two ropes at right angles to one another, which support tensions of T_1 and T_2 newtons. The rope supporting a tension of T_1 makes an angle of α to the vertical as shown in the diagram below.



Then,

A. $T_1 = 5\sin(\alpha)$ and $T_2 = 5\cos(\alpha)$

B. $T_1 = 5\cos(\alpha)$ and $T_2 = 5\sin(\alpha)$

C. $T_1 = 5\tan(\alpha)$ and $T_2 = \dfrac{5}{\tan(\alpha)}$

D. $T_1 = 49\sin(\alpha)$ and $T_2 = 49\cos(\alpha)$

E. $T_1 = 49\cos(\alpha)$ and $T_2 = 49\sin(\alpha)$

Mathematics Questions by Topics
Motion and Force Question 29 Source: K12SM2Q20

Question 29

A constant force of 10 newtons acts on a mass of 5 kg initially moving at 1 ms^{-1}. After the mass has moved a distance of 20 metres, the magnitude of the momentum in $kgms^{-1}$, is equal to

A. 9

B. 10

C. 40

D. 45

E. 50

Mathematics Questions by Topics
Motion and Force Question 30 Source: K11SM2Q15

Question 30

A hot air balloon is accelerating upwards with an acceleration of 1 m/s^2. At a particular instant it is 250 metres above ground level and rising upwards with a speed of 3 m/s. A small stone falls from the balloon to the ground. Assuming air resistance is negligible, the time taken, for the stone to hit the ground in seconds, is closest to

A. 7.89

B. 7.54

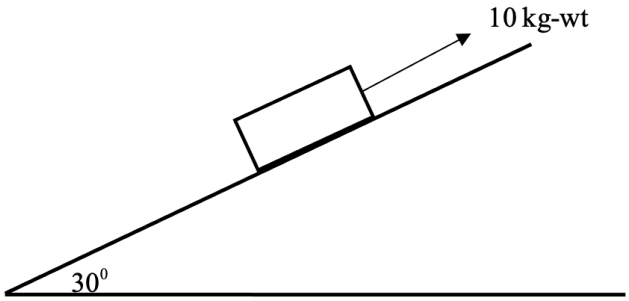
C. 7.46

D. 7.20

E. 7.14

Mathematics Questions by Topics
Motion and Force Question 31 Source: K11SM2Q17

Question 31



A box of mass 10 kg is at rest on a plane inclined at angle of 30^0 to the horizontal.
A force of magnitude 10 kg-wt acting up and parallel to the plane is applied to the box.

For equilibrium to be maintained, the co-efficient of friction between the box and the plane must be

A. at least $\frac{\sqrt{3}}{3}$

B. less than $\frac{\sqrt{3}}{3}$

C. at least $\frac{g-2}{g\sqrt{3}}$

D. less than $\frac{g-2}{g\sqrt{3}}$

E. at least $5g\sqrt{3}$

Mathematics Questions by Topics
Motion and Force Question 32 Source: K11SM2Q18

Question 32

A body of mass *m* kg moves in a straight line, its velocity is *v* ms^{-1} at a time *t* seconds. The force acting on the body is $f(t)$ newtons.

Given that $v = v_1$ when $t = t_1$ and $v = v_2$ when $t = t_2$, it follows that

A. $mv_2 - mv_1 = f(t_2) - f(t_1)$

B. $mv_2 - mv_1 = \int_{t_1}^{t_2} f(t)\,dt$

C. $v_2 - v_1 = m\int_{t_1}^{t_2} f(t)\,dt$

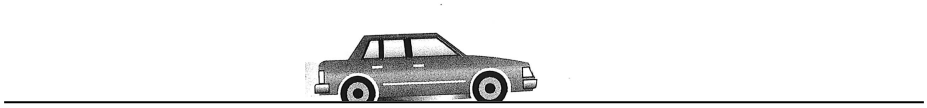
D. $\frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 = f(t_2) - f(t_1)$

E. $\frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 = \int_{t_1}^{t_2} f(t)\,dt$

Mathematics Questions by Topics
Motion and Force Question 33 Source: K11SM2Q19

Question 33

A car of mass *m* kg is travelling on a level roadway. The engine exerts a constant propulsive force of *F* newtons and the total resistance to the motion of the car is kv^3 newtons, where *k* is positive constant and *v* is its speed in m/s. The car moves from rest, the distance travelled in metres until it obtains a speed of *V*, is given by



A. $\dfrac{V^2}{2\left(F-kV^3\right)}$

B. $\dfrac{mV^2}{2\left(F-kV^3\right)}$

C. $\dfrac{m}{2}\displaystyle\int_0^V \frac{v^2}{F-kv^3}\,dv$

D. $\displaystyle\int_0^V \frac{mv}{F-kv^3}\,dv$

E. $\displaystyle\int_0^V \frac{v}{F-kv^3}\,dv$

Mathematics Questions by Topics
Motion and Force Question 34 Source: K10SM2Q13

Question 34

A particle of mass 5 kg, initially at rest is acted upon by two forces. One force has a magnitude of $5\sqrt{2}$ newtons acting in the north-west direction, the other force has magnitude of 10 newtons acting in the east direction. After two seconds, the magnitude of the momentum of the particle in kg ms^{-1} is equal to

A. $50\sqrt{2}$

B. $25\sqrt{2}$

C. $10\sqrt{2}$

D. $2\left(2-\sqrt{2}\right)$

E. $2\sqrt{2}$

Mathematics Questions by Topics
Motion and Force Question 35 Source: K10SM2Q17

Question 35

A body of mass *m* kg moves in a straight line. When its displacement is *x* m from the origin, its velocity is *v* ms^{-1} at a time *t* seconds. The force acting on the body is $mf\left(x\right)$ newtons. Given that $v = v_0$ when $x = x_0$ and $v = v_1$ when $x = x_1$, it follows that

A. $\frac{1}{2}mv_1^2 - \frac{1}{2}mv_0^2 = m\left[f\left(x_1\right) - f\left(x_0\right)\right]$

B. $\frac{1}{2}mv_1^2 - \frac{1}{2}mv_0^2 = m\int_{x_0}^{x_1} f\left(x\right)dx$

C. $v_1 - v_0 = \left[f\left(x_1\right) - f\left(x_0\right)\right]$

D. $v_1 - v_0 = \int_{x_0}^{x_1} f\left(x\right)dx$

E. $v_1 = \sqrt{v_0^2 + m\int_{x_0}^{x_1} f\left(x\right)dx}$

Mathematics Questions by Topics
Motion and Force Question 36 Source: K10SM2Q18

Question 36

An object of mass *m* kg is projected downwards from a point *P*, with an initial speed of of *U* m/s. The object falls under the influence of gravity in a medium which offers resistance proportional to the velocity. Take the initial position as $y = 0$ and downwards as the positive direction. If *k* is a positive constant, which of the following most accurately reflects the situation ?

A. $\ddot{y} - k\dot{y} = mg \quad y(0) = 0 \quad \dot{y}(0) = U$

B. $\ddot{y} - k\dot{y} = g \quad y(0) = 0 \quad \dot{y}(0) = -U$

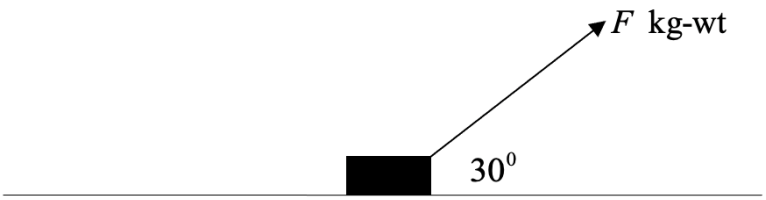
C. $\ddot{y} + k\dot{y} = mg \quad y(0) = 0 \quad \dot{y}(0) = U$

D. $\ddot{y} + k\dot{y} = mg \quad y(0) = 0 \quad \dot{y}(0) = -U$

E. $\ddot{y} + k\dot{y} = g \quad y(0) = 0 \quad \dot{y}(0) = U$

Mathematics Questions by Topics
Motion and Force Question 37 Source: K10SM2Q21

Question 37



A box of mass 3 kg is on a horizontal plane. A force of magnitude *F* kg-wt acting at an angle of 30^0 to the horizontal is applied to the box.

The coefficient of friction between the box and the plane is $\frac{\sqrt{3}}{2}$.

Which of the following is true?

A. If $F < 2g$ the box is not on the point of moving.

B. If $F < 2g$ the box moves with constant velocity.

C. If $F = 2$ the box moves with constant acceleration.

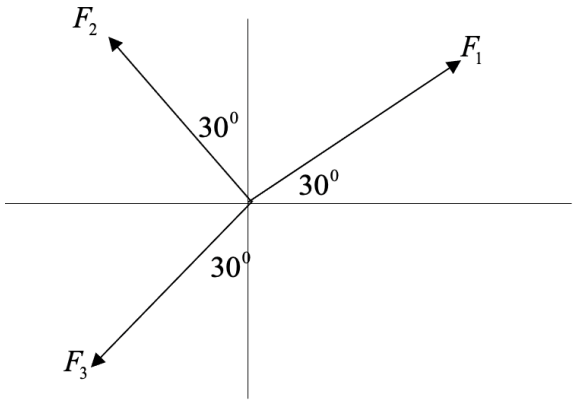
D. If $F > 2$ the box moves with constant velocity.

E. If $F > 2$ the box moves with constant acceleration.

Mathematics Questions by Topics
Motion and Force Question 38 Source: K9SM2Q11

Question 38

Three co-planar forces, F_1, F_2, F_3 act on a particle in equilibrium as shown in the diagram below



It follows that

A. $F_1 = F_2 = F_3$

B. $3F_2 = \sqrt{3}F_1$ and $F_2 = \frac{2}{3}F_3$

C. $F_1 = \sqrt{3}F_2$ and $F_3 = 2F_2$

D. $\sqrt{3}F_1 = 3F_2$ and $F_2 = \frac{3}{2}F_3$

E. $\sqrt{3}F_3 = 3F_2$ and $F_1 = \frac{3}{2}F_3$

Mathematics Questions by Topics
Motion and Force Question 39 Source: K9SM2Q18

Question 39

A parcel of mass 2 kg, is at rest on a rough horizontal table. The coefficient of friction between the parcel and the table is 0.25. A constant horizontal force of 10 newtons is applied to the parcel. Two seconds later the magnitude of the momentum of the parcel in kg m/s is equal to

A. 5.1

B. 10

C. 10.2

D. 20

E. 186.2

Mathematics Questions by Topics
Motion and Force Question 40 Source: K9SM2Q21

Question 40

A sand bag of mass 9 kg is dropped from a stationary hot-air balloon, which is 150 metres above the ground. Which of the following is true?

A. The sand bag hits the ground after 5.48 seconds, with a speed of 54.78m/s.

B. The sand bag hits the ground after 5.48 seconds, with a speed of 53.68 m/s.

C. The sand bag hits the ground after 5.53 seconds, with a speed of 55.33m/s.

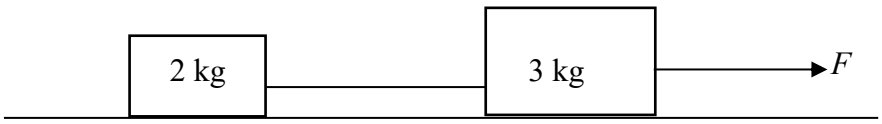
D. The sand bag hits the ground after 5.53 seconds, with a speed of 54.22m/s.

E. The sand bag hits the ground after 5.68 seconds with a speed of 50m/s.

Mathematics Questions by Topics
Motion and Force Question 41 Source: K9SM2Q22

Question 41

Two boxes of masses 2 kg and 3 kg are connected by a light horizontal string and are on a horizontal table, as shown in the diagram below. The coefficient of friction between both boxes and the table is $\frac{1}{7}$. The 3 kg box is pulled by a force of F, parallel to the table. Which of the following is true?



A. If $F > 7$ newtons, the boxes move with constant acceleration.

B. If $5 < F < 7$ newtons, the boxes are on the point of moving.

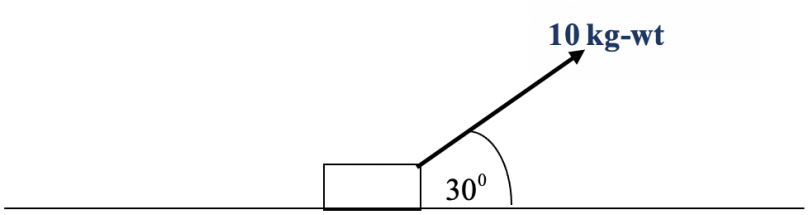
C. If $F = 7$ newtons, the boxes move with constant velocity.

D. If $F > 7\,\text{kg-wt},$ the boxes move with constant velocity.

E. If $F = 7\,\text{kg-wt},$ the boxes are not on the point of moving.

Mathematics Questions by Topics
Motion and Force Question 42 Source: K8SM2Q13

Question 42



A box of mass 20 kg is at rest on a horizontal plane. A force of magnitude 10 kg-wt acting at an angle of 30^0 to the horizontal is applied to the block. For equilibrium to be maintained, the coefficient of friction between the box and the plane must be

A. at least $\frac{\sqrt{3}}{3}$

B. less than $\frac{\sqrt{3}}{3}$

C. at least $\frac{\sqrt{3}}{4}$

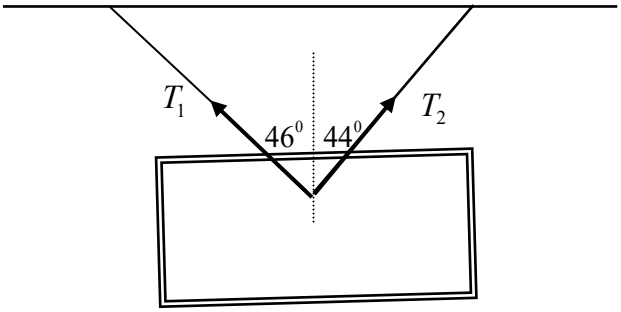
D. at least $\frac{\sqrt{3}}{4g}$

E. less than $\frac{\sqrt{3}}{4g}$

Mathematics Questions by Topics
Motion and Force Question 43 Source: K8SM2Q14

Question 43

A painting of mass one kilogram is to be hung on a wall using two light strings. Unfortunately the painting is not quite horizontal. One string makes an angle of 46^0 with the vertical and has a tension of magnitude T_1 newtons. The other string makes an angle of 44^0 with the vertical and has a tension of magnitude T_2 newtons, as shown in the diagram below.



Which of the following is true?

A. $\frac{T_1}{T_2} = \tan\left(44^0\right)$

B. $\frac{T_1}{T_2} = \tan\left(46^0\right)$

C. $T_1 + T_2 = g$

D. $T_1^2 + T_2^2 = g^2$

E. $T_1 = T_2$

Mathematics Questions by Topics
Motion and Force Question 44 Source: K8SM2Q18

Question 44

A hot air balloon is accelerating vertically upwards with an acceleration of 1 m/s^2. A stone is dropped from the balloon when it is *h* metres above the ground. The stone strikes the ground 8 seconds later. Assuming the air resistance is negligible, the value of *h* is closest to

A. 282.

B. 290.

C. 314.

D. 322.

E. 346.

Mathematics Questions by Topics
Motion and Force Question 45 Source: K7SM2Q16

Question 45

A particle travels in a straight line with velocity *v* at a time *t* and its displacement is *x*.
If $v^2 = 9x$ for $x > 0$, then the acceleration of the particle is given by

A. $\frac{2x}{3}$

B. 4.5

C. $2\sqrt{x^3}$

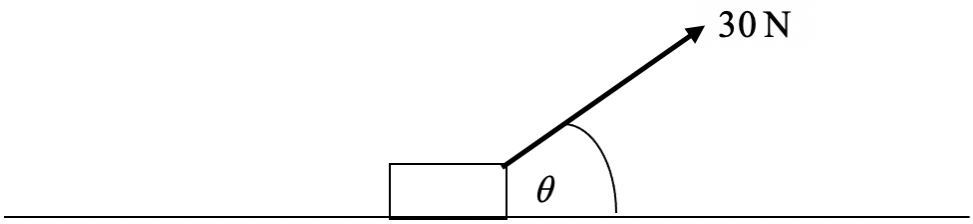
D. $6x^2$

E. $\frac{3}{2\sqrt{x}}$

Mathematics Questions by Topics
Motion and Force Question 46 Source: K7SM2Q17

Question 46

A box of mass 10 kg is on a horizontal plane. A rope makes an angle of θ^0 with the horizontal and exerts a tension of 30 newtons.



If the coefficient of friction between the block and the surface is 0.2, which one of the following values of θ produces the largest acceleration of the block?

A. $\theta = 0$

B. $\theta = 5$

C. $\theta = 10$

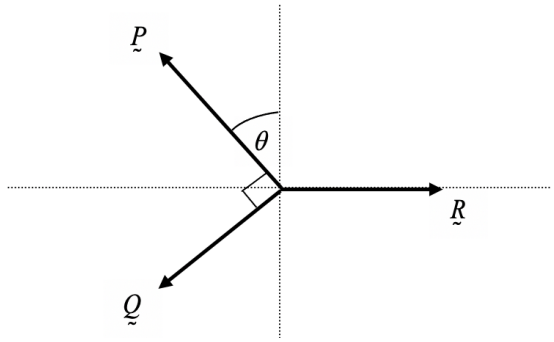
D. $\theta = 15$

E. $\theta = 20$

Mathematics Questions by Topics
Motion and Force Question 47 Source: K7SM2Q18

Question 47

The following diagram shows a particle in equilibrium under the action of three concurrent coplanar forces $\underset{\sim}{P}$, $\underset{\sim}{Q}$ and $\underset{\sim}{R}$. The forces $\underset{\sim}{P}$, $\underset{\sim}{Q}$ and $\underset{\sim}{R}$ have magnitudes of P, Q and R respectively. Which one of the following statements is **not** correct?



A. $P\text{cosec}(\theta) = Q\sec(\theta)$

B. $R^2 = P^2 + Q^2$

C. $R = P\sin(\theta) + Q\cos(\theta)$

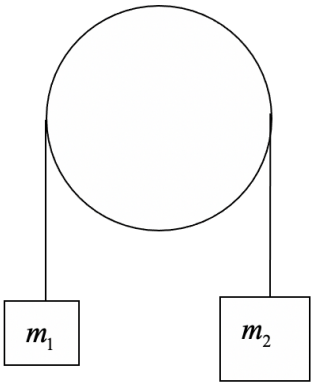
D. $\cot(\theta) = \dfrac{P}{Q}$

E. $\underset{\sim}{P} + \underset{\sim}{Q} + \underset{\sim}{R} = \underset{\sim}{0}$

Mathematics Questions by Topics
Motion and Force Question 48 Source: K7SM2Q21

Question 48

A light inextensible string passes over a smooth pulley. Particles of masses m_1 and m_2 are attached to each end of the string as shown in the diagram.



If the mass m_2 accelerates downwards at $\frac{g}{5}$ m/s^2, then the ratio $\frac{m_2}{m_1}$ is equal to

A. 1

B. $\frac{3}{2}$

C. $\frac{2}{3}$

D. 5

E. $\frac{5}{4}$

Mathematics Questions by Topics
Motion and Force Question 49 Source: K5SM1Q25

Question 49

A suitcase of mass 12 kilograms rests on a rough, level ground. The suitcase is pulled with a force of magnitude P newtons acting at an angle of $30°$ to the horizontal. The suitcase is just on the point of sliding along the ground. If the coefficient of friction between the suitcase and the plane is 0.25, then P is closest to

A. 58.8

B. 29.67

C. 39.67

D. 3.03

E. 33.95

Mathematics Questions by Topics
Motion and Force Question 50 Source: K5SM1Q29

Question 50

A block of mass m kg is lying on a smooth horizontal table and is joined by a light inextensible string to a another block of mass of $2m$ kg hanging vertically. This string passes over a smooth pulley at the edge of the table. When the system is released from rest, the acceleration of the blocks in m/s^2 is given by

A. $\frac{2}{3}$

B. $\frac{2g}{3}$

C. 1

D. $2g$

E. g

End of
MATHEMATICS QUESTIONS BY TOPICS
MOTION AND FORCE
50 Multiple Choice Questions

MATHEMATICS QUESTIONS BY TOPICS

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Mathematics Questions by Topics
Motion and Force – Multiple Choice

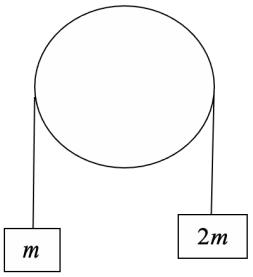
Answer Summary

Index – Click on the answer.

Mathematics Questions by Topic
Motion and Force Answer 1 Source: K22SM2Q14

Question 1

Two masses of mass *m* and 2*m* kg are hanging vertically and connected by a light string which passes over a smooth pulley. In this situation the mass $2m$ moves downwards with an acceleration of $a\ \text{ms}^{-2}$ and the tension in the string is T_1 newtons. When an extra mass of 3*m* is added to the mass *m*, it now moves down with the same acceleration of $a\ \text{ms}^{-2}$ and the tension in the string is T_2 newtons. The ratio $\frac{T_2}{T_1}$ is equal to.



A. $\frac{1}{3}$

B. 1

C. 2

D. 3

E. 4

ANSWER C

with masses m_1 and m_2, assume $m_2 > m_1$ $(1)\ m_2 g - T = m_2 a$ $(2)\ T - m_1 g = m_1 a$,

then solving for the tension in the string $T = \frac{2m_1 m_2 g}{m_1 + m_2}$

Case (1) $m_1 = m,\ m_2 = 2m,\ T_1 = \frac{2m^2 g}{3m} = \frac{2mg}{3}$

Case (2) $m_1 = 4m,\ m_2 = 2m,\ T_2 = \frac{8m^2 g}{6m} = \frac{4mg}{3}$

$\frac{T_2}{T_1} = 2$

Mathematics Questions by Topic
Motion and Force Answer 2 Source: K22SM2Q17

Question 2

A particle of mass *m* kg slides from rest down a smooth inclined plane, and travels a distance of *S* metres down the plane in a time of T_1 seconds. Another particle of mass 2*m* kg is placed on the same plane and travels a distance of 2*S* metres down the plane in a time of T_2, seconds, then

A. $T_2 = 4T_1$

B. $T_2 = 2T_1$

C. $T_2 = T_1$

D. $T_2 = \frac{T_1}{2}$

E. $T_2 = \sqrt{2}\,T_1$

ANSWER E

$ma = -mg\sin(\theta)$

$a = -g\sin(\theta),\ \ u = 0$

Note that when the mass is 2*m* the acceleration down the plane is the same, using

$s = ut + \frac{1}{2}at^2$

Mathematics Questions by Topic
Motion and Force Answer 3 Source: K21SM2Q12

Question 3
A particle of mass 5 kg is on a rough horizontal plane. The particle is acted upon up by a force of T newtons acting at an angle of 60^0 to the plane. A frictional force of $\frac{49\sqrt{3}}{3}$ newtons acting parallel to the plane, opposes the motion. Then if

A. $T=\frac{98\sqrt{3}+30}{3}$ the particle moves along the plane with an acceleration of $1\ \text{ms}^{-2}$.

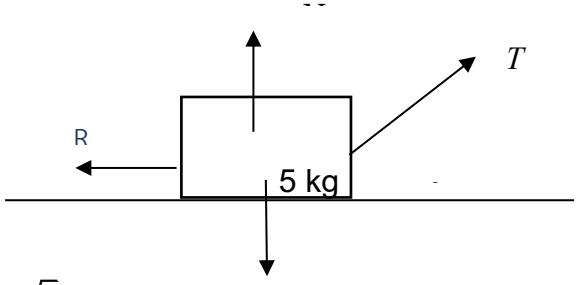
B. $T=\frac{98\sqrt{3}-30}{3}$ the particle moves along the plane with an acceleration of $1\ \text{ms}^{-2}$.

C. $T=\frac{98\sqrt{3}+60}{3}$ the particle moves along the plane with an acceleration of $2\ \text{ms}^{-2}$.

D. $T=\frac{98\sqrt{3}-60}{3}$ the particle moves along the plane with an acceleration of $2\ \text{ms}^{-2}$.

E. $T<\frac{98\sqrt{3}}{3}$ the particle does not move.

ANSWER E



The resistance force $R=\frac{49\sqrt{3}}{3}$

Resolving horizontally around the 5 kg mass $(1)\ T\cos\left(60^0\right)-R=5a$

Now $(1)\ a=0$, $T\cos\left(60^0\right)-R=0$, $T\times\frac{1}{2}=\frac{49\sqrt{3}}{3}\Rightarrow T=\frac{98\sqrt{3}}{3}$ but

Resolving vertically around the 5 kg mass $(2)\ N+T\sin\left(60^0\right)-5g=0$

Now if $N=0$ then $T\sin\left(60^0\right)-5g=0$, $T=\frac{5g}{\sin\left(60^0\right)}=\frac{49}{\frac{\sqrt{3}}{2}}=\frac{98}{\sqrt{3}}=\frac{98\sqrt{3}}{3}$

therefore when $T\geq\frac{98\sqrt{3}}{3}$, $N\leq 0$ the particle is no longer on the plane.

A. **B**. **C**. and **D**. are false, only **E**. is true, when $T<\frac{98\sqrt{3}}{3}$ the particle does not move.

Mathematics Questions by Topic
Motion and Force Answer 4 Source: K21SM2Q15

Question 4

A particle of mass 2 kg, is moving so that its velocity vector at a time *t*, given by $\dot{\underset{\sim}{r}}(t) = 4\sin^2(t)\underset{\sim}{i} + 4\cos^2(t)\underset{\sim}{j}$, for $t \geq 0$, given that $\underset{\sim}{r}\left(\frac{\pi}{4}\right) = \frac{\pi}{2}\left(\underset{\sim}{i} + \underset{\sim}{j}\right)$

The change in momentum over $\frac{\pi}{6} \leq t \leq \frac{\pi}{4}$, is given by

A. $-2\underset{\sim}{i} + 2\underset{\sim}{j}$.

B. $2\underset{\sim}{i} - 2\underset{\sim}{j}$.

C. $\underset{\sim}{i} - \underset{\sim}{j}$

D. $-\underset{\sim}{i} + \underset{\sim}{j}$

E. $2\sqrt{2}$

ANSWER B

$$\dot{\underset{\sim}{r}}\left(\frac{\pi}{6}\right) = 4\sin^2\left(\frac{\pi}{6}\right)\underset{\sim}{i} + 4\cos^2\left(\frac{\pi}{6}\right)\underset{\sim}{j} = \underset{\sim}{i} + 3\underset{\sim}{j}$$

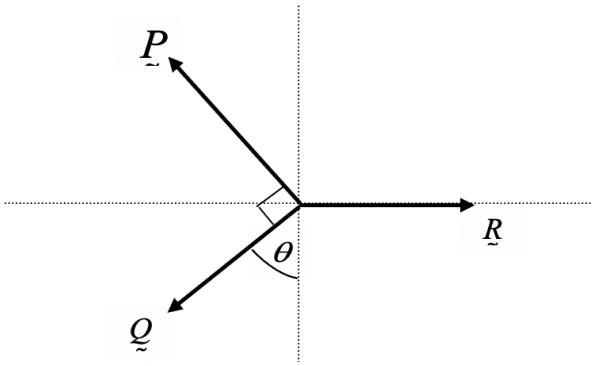
$$\dot{\underset{\sim}{r}}\left(\frac{\pi}{4}\right) = 4\sin^2\left(\frac{\pi}{4}\right)\underset{\sim}{i} + 4\cos^2\left(\frac{\pi}{4}\right)\underset{\sim}{j} = 2\underset{\sim}{i} + 2\underset{\sim}{j}$$

$$\underset{\sim}{p} = m\left(\dot{\underset{\sim}{r}}\left(\frac{\pi}{4}\right) - \dot{\underset{\sim}{r}}\left(\frac{\pi}{6}\right)\right) = 2\left(\left(2\underset{\sim}{i} + 2\underset{\sim}{j}\right) - \left(\underset{\sim}{i} + 3\underset{\sim}{j}\right)\right)$$

$$\underset{\sim}{p} = 2\underset{\sim}{i} - 2\underset{\sim}{j}$$

Mathematics Questions by Topic
Motion and Force Answer 5 Source: K20SM2Q10

Question 5
The following diagram shows a particle in equilibrium under the action of three concurrent coplanar forces $\underset{\sim}{P}$, $\underset{\sim}{Q}$ and $\underset{\sim}{R}$. The forces $\underset{\sim}{P}$, $\underset{\sim}{Q}$ and $\underset{\sim}{R}$ have magnitudes of P, Q and R respectively. Which one of the following statements is **not** correct?



A. $P\sec(\theta)=Q\operatorname{cosec}(\theta)$

B. $\cot(\theta)=\dfrac{P}{Q}$

C. $R=Q\sin(\theta)+P\cos(\theta)$

D. $R^2=P^2+Q^2$

E. $P+Q+R=0$

ANSWER E
resolving vertically $P\cos(90-\theta)-Q\cos(\theta)=0 \Rightarrow P\sin(\theta)=Q\cos(\theta)$

$\dfrac{P}{\cos(\theta)}=\dfrac{Q}{\sin(\theta)}$, $P\sec(\theta)=Q\operatorname{cosec}(\theta)$ **A**. is true

$\dfrac{P}{Q}=\dfrac{\cos(\theta)}{\sin(\theta)}=\cot(\theta)$ **B**. is true

resolving horizontally $R-Q\sin(\theta)-P\sin(90-\theta)=0 \Rightarrow R=Q\sin(\theta)+P\cos(\theta)$ **C**. is true

D. is true $R^2=P^2+Q^2$ as magnitudes

$\underset{\sim}{P}+\underset{\sim}{Q}+\underset{\sim}{R}=\underset{\sim}{0}$ as vectors is true, but as magnitudes $P+Q+R\neq 0$ **E.** is false

Mathematics Questions by Topic
Motion and Force Answer 6 Source: K20SM2Q19

Question 6

A body is moving in a straight line. When its displacement is *x* metres from the origin at time *t* seconds, $t = x\cos(2x)$. The acceleration in ms^{-2} is given by

A. $\dfrac{-2\sin(2x)}{\cos^3(2x)}$

B. $\dfrac{4(\sin(2x)+x\cos(2x))}{(\cos(2x)-2x\sin(2x))^3}$

C. $\dfrac{4(\sin(2x)+x\cos(2x))}{(\cos(2x)-2x\sin(2x))^2}$

D. $\dfrac{1}{\cos(2x)-2x\sin(2x)}$

E. $-4(x\cos(2x)+2\sin(2x))$

ANSWER B

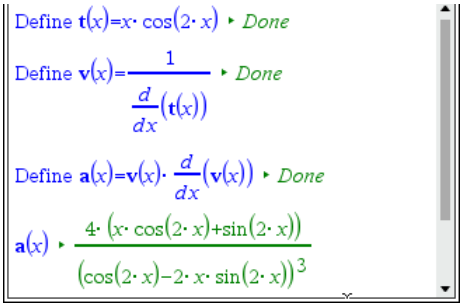
$$t = x\cos(2x) \Rightarrow \frac{dt}{dx} = \cos(2x) - 2x\sin(2x)$$

$$v = \frac{dx}{dt} = \frac{1}{\cos(2x)-2x\sin(2x)} = (\cos(2x)-2x\sin(2x))^{-1}$$

$$\Rightarrow \frac{dv}{dx} = \frac{-(-2\sin(2x)-2\sin(2x)-4x\cos(2x))}{(\cos(2x)-2x\sin(2x))^2}$$

$$\frac{dv}{dx} = \frac{4(\sin(2x)+x\cos(2x))}{(\cos(2x)-2x\sin(2x))^2}$$

$$a = v\frac{dv}{dx} = \frac{4(\sin(2x)+x\cos(2x))}{(\cos(2x)-2x\sin(2x))^3}$$



Mathematics Questions by Topic
Motion and Force Answer 7 Source: K20SM2Q20

Question 7

A particle of mass *m* kg falls vertically downwards, from rest in a medium which offers air resistance equal to kv^2 newtons, where v ms^{-1} is its velocity at a time *t* seconds. After a time *T* seconds, its velocity is V ms^{-1} and it has travelled a distance of *D* metres.
Which of the following is **false**?

A. $m\dfrac{dv}{dt} = mg - kv^2$

B. $D = \displaystyle\int_0^V \frac{mv}{mg - kv^2}\,dv$

C. $V = \dfrac{D}{T}$

D. $T = \displaystyle\int_0^V \frac{m}{mg - kv^2}\,dv$

E. Its limiting or terminal velocity is equal to $\sqrt{\dfrac{mg}{k}}$ ms^{-1}.

ANSWER C

$\ddot{x} = \dfrac{dv}{dt}$, $m\dfrac{dv}{dt} = mg - kv^2$ **A.** is true.

$\dfrac{dv}{dt} = \dfrac{mg - kv^2}{m}$, $\dfrac{dt}{dv} = \dfrac{m}{mg - kv^2}$, $T = \displaystyle\int_0^V \frac{m}{mg - kv^2}\,dv$, **D.** is true.

use $\ddot{x} = v\dfrac{dv}{dx}$, $mv\dfrac{dv}{dx} = mg - kv^2$, $\dfrac{dv}{dx} = \dfrac{mg - kv^2}{mv}$, $\dfrac{dx}{dv} = \dfrac{mv}{mg - kv^2}$

$D = \displaystyle\int_0^V \frac{mv}{mg - kv^2}\,dv$ **B.** is true.

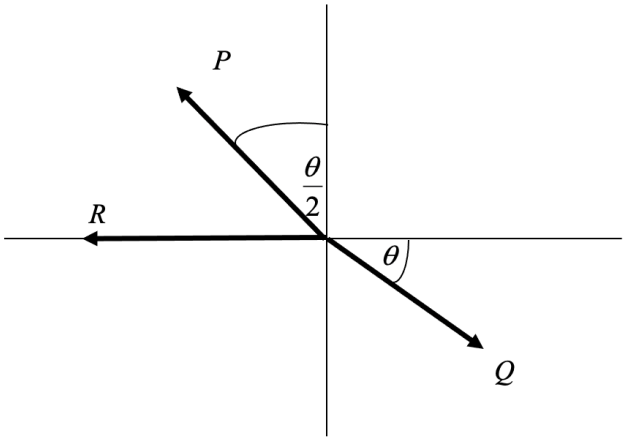
The limiting or terminal velocity occurs when $\ddot{x} = 0$ $v_{\lim} = \sqrt{\dfrac{mg}{k}}$ ms^{-1}, **E.** is true.

$V = \dfrac{D}{T}$ is false, constant acceleration formulae do not apply.

Mathematics Questions by Topic
Motion and Force Answer 8 Source: K19SM2Q12

Question 8

Three coplanar forces of magnitudes *P*, *Q* and *R* newtons act on a particle that is in equilibrium as shown in the diagram below.



Then,

A. $P\sin\left(\frac{\theta}{2}\right)=Q\cos(\theta)$

B. $P\cos\left(\frac{\theta}{2}\right)+R=Q\sin(\theta)$

C. $P=Q\sin\left(\frac{\theta}{2}\right)$

D. $P=2Q\sin\left(\frac{\theta}{2}\right)$

E. $P+Q+R=0$

ANSWER D

resolving horizontally $P\sin\left(\frac{\theta}{2}\right)+R=Q\cos(\theta)$

resolving vertically $P\cos\left(\frac{\theta}{2}\right)=Q\sin(\theta)=2Q\sin\left(\frac{\theta}{2}\right)\cos\left(\frac{\theta}{2}\right)$

therefore $P=2Q\sin\left(\frac{\theta}{2}\right)$

Mathematics Questions by Topic
Motion and Force Answer 9 Source: K19SM2Q14

Question 9

A particle of mass 3 kg travels in a straight line with velocity v ms^{-1} when its displacement is *x* metres, where $v=\sqrt{4x^2+9}$. The force in newtons acting on the particle when $x=2$ is

A. 24

B. 12

C. 8

D. 4

E. $\frac{24}{5}$

ANSWER A

$v=\sqrt{4x^2+9}$, $\frac{dv}{dx}=\frac{4x}{\sqrt{4x^2+9}}$, $m=3$

$F=ma=mv\frac{dv}{dx}=3\times 4x=12x$

when $x=2$, $F=24$

Mathematics Questions by Topic
Motion and Force Answer 10 Source: K19SM2Q17

Question 10

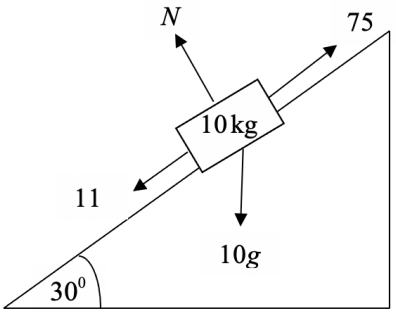
An object of mass 10 kg is initially at rest on a rough plane inclined at an angle of 30^0 to the horizontal. The object is pulled up the plane by a force of 75 N acting up and parallel to the plane. A frictional force of 11 N acting parallel to the plane, opposes the motion. After the pulling force has acted for 2 seconds, the magnitude of the momentum of the particle in kg ms^{-1} is closest to

A. 10
B. 20
C. 30
D. 40
E. 50

ANSWER C

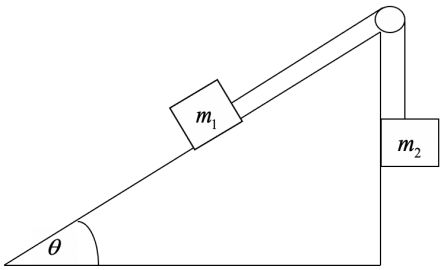
resolving parallel to the plane

$$75-11-10g\sin\left(30^0\right)=10a$$
$$64-5g=64-49=15=10a$$
$$a=\frac{3}{2}\ ,\ u=0\ ,\ t=2\ ,\ m=10$$
$$v=u+at$$
$$v=0+\frac{3}{2}\times 2=3$$
$$p=mv=30\,\text{kg ms}^{-1}$$



Mathematics Questions by Topic
Motion and Force Answer 11 Source: K18SM2Q15

Question 11
A particle of mass m_1 kg is on a smooth plane, inclined at an angle of θ to the horizontal. It is connected by a light string which passes around a smooth pulley to another mass of m_2 kg hanging vertically, as shown in the diagram.



Then which of the following is **false?**

A. If $\theta = 30^0$ and $\frac{m_2}{m_1} = \frac{1}{2}$ then the system is in equilibrium.

B. If $\theta = 30^0$ and $\frac{m_2}{m_1} < \frac{1}{2}$ then the mass m_2 moves upwards.

C. If $\theta = 45^0$ and $\frac{m_2}{m_1} = \frac{\sqrt{2}}{2}$ then the system is in equilibrium.

D. If $\theta = 60^0$ and $\frac{m_2}{m_1} = \frac{\sqrt{3}}{2}$ then the system is in equilibrium.

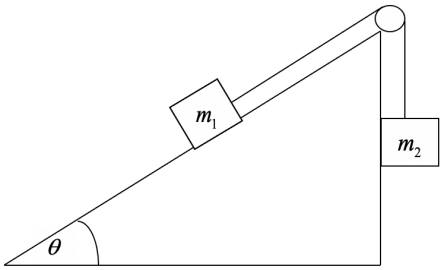
E. If $\theta = 60^0$ and $\frac{m_2}{m_1} < \frac{\sqrt{3}}{2}$ then the mass m_2 moves downwards.

ANSWER E

See next page . . .

Mathematics Questions by Topic

Motion and Force Answer 11 Source: K18SM2Q15



resolving up parallel to plane around the m_1 kg mass $(1)\ T - m_1 g\sin(\theta) = m_1 a$

resolving downwards around the m_2 kg mass $(2)\ m_2 g - T = m_2 a$

adding to eliminate the tension in the string, to find the acceleration *a*, of the system

$(1)+(2)\ m_2 g - m_1 g\sin(\theta) = m_1 a + m_2 a \ \Rightarrow\ a = \dfrac{g\left(m_2 - m_1\sin(\theta)\right)}{m_1 + m_2}$

Checking the alternatives

$a > 0$ when $m_2 > m_1\sin(\theta) \ \Rightarrow\ \dfrac{m_2}{m_1} > \sin(\theta)$

and $a = 0$ when $\dfrac{m_2}{m_1} = \sin(\theta)$

If $\theta = 30^0$ and $\dfrac{m_2}{m_1} = \sin(30^0) = \dfrac{1}{2}$ then the system is in equilibrium, **A.** is correct

If $\theta = 30^0$ $a = \dfrac{g\left(m_2 - \dfrac{m_1}{2}\right)}{m_1 + m_2}$ if $\dfrac{m_2}{m_1} < \dfrac{1}{2}$ then $a < 0$

therefore the mass m_2 moves upwards, **B.** is correct

If $\theta = 45^0$ and $\dfrac{m_2}{m_1} = \sin(45^0) = \dfrac{\sqrt{2}}{2}$ then the system is in equilibrium, **C.** is correct

If $\theta = 60^0$ and $\dfrac{m_2}{m_1} = \sin(60^0) = \dfrac{\sqrt{3}}{2}$ then the system is in equilibrium, **D.** is correct

If $\theta = 60^0$ $a = \dfrac{g\left(m_2 - \dfrac{\sqrt{3}\,m_1}{2}\right)}{m_1 + m_2}$ if $\dfrac{m_2}{m_1} < \dfrac{\sqrt{3}}{2}$ then $a < 0$

therefore the mass m_2 moves upwards, **E.** is incorrect

Mathematics Questions by Topic
Motion and Force Answer 12 Source: K18SM2Q16

Question 12
A body is moving in a straight line. When its displacement is *x* metres from the origin at time *t* seconds, then $t = e^{kx}$, where *k* is a non-zero constant. The acceleration in ms^{-2} is given by

A. $-e^{-kx}$

B. $-\dfrac{e^{-kx}}{k^2}$

C. $-\dfrac{e^{-2kx}}{k}$

D. $-k$

E. e^{-2kx}

ANSWER C

$$t = e^{kx} \Rightarrow \frac{dt}{dx} = ke^{kx}$$

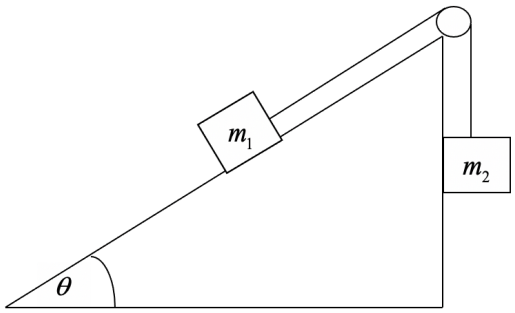
$$v = \frac{dx}{dt} = \frac{1}{k}e^{-kx} \Rightarrow \frac{dv}{dx} = -e^{-kx}$$

$$a = v\frac{dv}{dx} = -\frac{1}{k}e^{-2kx}$$

Mathematics Questions by Topic
Motion and Force Answer 13 Source: K17SM2Q13

Question 13

A particle of mass m_1 kg is on a smooth plane, inclined at an angle of θ to the horizontal. It is connected by a light string which passes around a smooth pulley to another mass of m_2 kg hanging vertically, as shown in the diagram.



Which of the following is **false?**

A. The tension in the string is equal to $\dfrac{m_1 m_2\left(1+\sin(\theta)\right)}{m_1+m_2}$ kg-wt.

B. If $m_2 > m_1\sin(\theta)$ the mass m_2 moves downwards with an acceleration $\dfrac{g\left(m_2 - m_1\sin(\theta)\right)}{m_1+m_2}$ ms^{-2}.

C. If $m_2 = m_1\sin(\theta)$ the masses remain at rest.

D. If $m_2 = 2m_1$ and $\theta = 30^0$ the tension in the string is $\dfrac{g}{2}$ newtons.

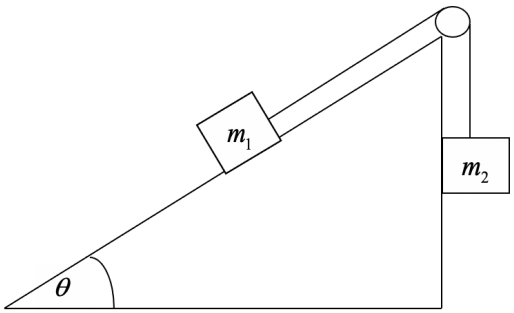
E. If $m_2 = 2m_1$ and $\theta = 30^0$ the mass m_2 moves downwards with an acceleration $\dfrac{g}{2}$ ms^{-2}.

ANSWER D

See next page . . .

Mathematics Questions by Topic

Motion and Force Answer 13 Source: K17SM2Q13



resolving up parallel to plane around the m_1 kg mass $(1)\ \ T - m_1 g\sin(\theta) = m_1 a$

resolving downwards around the m_2 kg mass $(2)\ \ m_2 g - T = m_2 a$

adding to eliminate the tension in the string, to find the acceleration *a*, of the system

$(1)+(2)\ \ m_2 g - m_1 g\sin(\theta) = m_1 a + m_2 a \ \Rightarrow\ a = \dfrac{g\left(m_2 - m_1\sin(\theta)\right)}{m_1 + m_2}$

$a > 0$ when $m_2 > m_1\sin(\theta)$ and $a = 0$ when $m_2 = m_1\sin(\theta)$

B. and **C**. are correct.

$(1)\times m_2\ \ Tm_2 - m_1 m_2 g\sin(\theta) = m_1 m_2 a$

$(2)\times m_1\ \ m_2 m_1 g - Tm_1 = m_1 m_2 a$ subtracting to eliminate the acceleration, gives

the tension in the string is equal to $\dfrac{m_1 m_2 g\left(1+\sin(\theta)\right)}{m_1 + m_2}$ newtons or $\dfrac{m_1 m_2\left(1+\sin(\theta)\right)}{m_1 + m_2}$ kg-wt.

A. is correct.

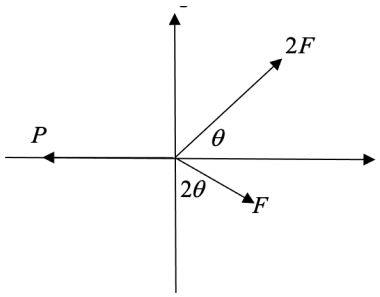
When $m_2 = 2m_1$ and $\theta = 30^0$, $T = \dfrac{m_1 \times 2m_1 g\left(1+\dfrac{1}{2}\right)}{m_1 + 2m_1} = m_1 g$ newtons. **D.** is incorrect

When $m_2 = 2m_1$ and $\theta = 30^0$, $a = \dfrac{g\left(2m_1 - \dfrac{m_1}{2}\right)}{m_1 + 2m_1} = \dfrac{g}{2}\ \text{ms}^{-2}$ **E.** is correct

Mathematics Questions by Topic
Motion and Force Answer 14 Source: K16SM2Q17

Question 14

A body is on a horizontal smooth plane and acted upon by three forces, with magnitudes and directions as shown in the diagram below.



The correct statement relating the magnitude of the forces and the angle θ is

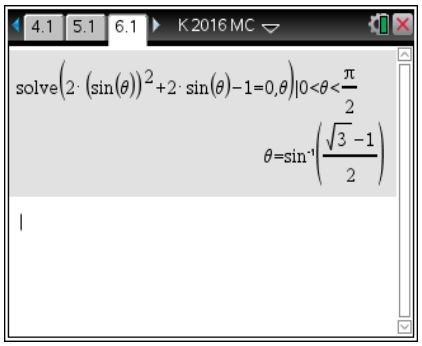
A. $P = 3F$

B. $P = 3F\sin(3\theta)$

C. $P = 3F\cos(3\theta)$

D. $P = 2F\sin(\theta) + F\cos(2\theta)$

E. $\theta = \sin^{-1}\left(\frac{\sqrt{3}-1}{2}\right)$



ANSWER E

resolving horizontally (1) $\quad 2F\cos(\theta) + F\sin(2\theta) - P = 0$

resolving vertically (2) $\quad 2F\sin(\theta) - F\cos(2\theta) = 0$ $(2) \Rightarrow F\left(2\sin(\theta) - \cos(2\theta)\right) = 0$

$2\sin(\theta) - \cos(2\theta) = 0$

$2\sin(\theta) - \left(1 - 2\sin^2(\theta)\right) = 0$

$2\sin^2(\theta) + 2\sin(\theta) - 1 = 0$

$\sin(\theta) = \frac{\sqrt{3}-1}{2}$

since $\quad 0 < \sin(\theta) < 1$ and $\quad 0 < \theta < \frac{\pi}{2}$

$\Rightarrow \quad \theta = \sin^{-1}\left(\frac{\sqrt{3}-1}{2}\right)$

Mathematics Questions by Topic
Motion and Force Answer 15 Source: K15SM2Q15

Question 15

The position vector of a 2 kg moving particle is given by $\underset{\sim}{r}(t) = 4\sin(t)\underset{\sim}{i} + \cos(2t)\underset{\sim}{j}$ where the position in measured in metres and $t \geq 0$ is the time in seconds. The maximum momentum in kg-m/s of the particle is

A. 8

B. 4

C. 2

D. 1

E. $2\sqrt{5}$

ANSWER A

$$\underset{\sim}{r}(t) = 4\sin(t)\underset{\sim}{i} + \cos(2t)\underset{\sim}{j}$$

$$\dot{\underset{\sim}{r}}(t) = 4\cos(t)\underset{\sim}{i} - 2\sin(2t)\underset{\sim}{j}$$

$$\left|\dot{\underset{\sim}{r}}(t)\right| = \sqrt{\left(4\cos(t)\right)^2 + \left(-2\sin(2t)\right)^2} = \sqrt{16\cos^2(t) + 4\sin^2(2t)}$$

$$= \sqrt{16\cos^2(t) + 4\left(2\sin(t)\cos(t)\right)^2} = \sqrt{16\cos^2(t) + 16\sin^2(t)\cos^2(t)}$$

$$= \sqrt{16\cos^2(t)\left(1 + \sin^2(t)\right)} = \sqrt{16\cos^2(t)\left(2 - \cos^2(t)\right)}$$

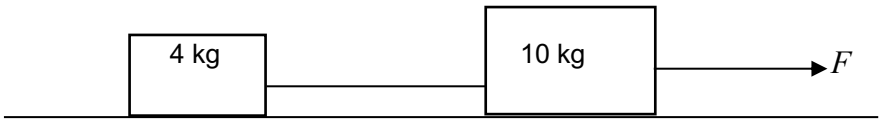
when $\cos(t) = 1$ $\left|\dot{\underset{\sim}{r}}(t)\right|_{\max} = 4$, $m = 2$ $p_{\max} = mv = 8$ kg m/s

Mathematics Questions by Topic

Motion and Force Answer 16 Source: K15SM2Q16

Question 16

Two boxes of masses 10 kg and 4 kg are connected by a light horizontal string and are on a horizontal table, as shown in the diagram below. The coefficient of friction between the 10 kg box and the table is 0.5.The contact between the 4 kg block and table is smooth. The 10 kg box is pulled by a force of F, parallel to the table. Which of the following is **false?**



A. If $F = 50$ newtons, the boxes move with a constant acceleration equal to $\frac{1}{14}$ m/s^2

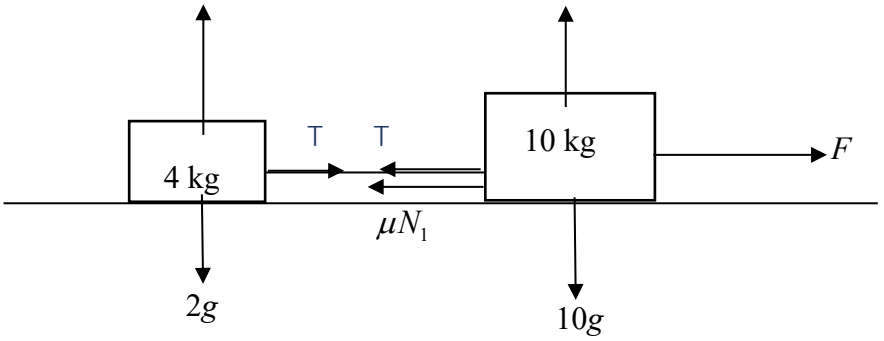
B. If $F = 49$ newtons, the boxes are on the point of moving.

C. If $F = 48$ newtons, the boxes move with constant velocity.

D. If $F = 47$ newtons the boxes remain at rest.

E. If $F = 46$ newtons

ANSWER C



Resolving horizontally around the 10 kg mass, $(1)\ F - T - \mu N_1 = 10a$

Resolving vertically around the 10 kg mass, $(2)\ N_1 - 10g = 0 \Rightarrow N_1 = 10g$

Resolving horizontally around the 4 kg mass, $(3)\ T = 4a$

substituting $\mu = 0.5$, $N_1 = 10g$ $T = 4a$

(1) becomes $F - 4a - 5g = 10a$ or (1) becomes $F = 14a + 5g = 14a + 49$

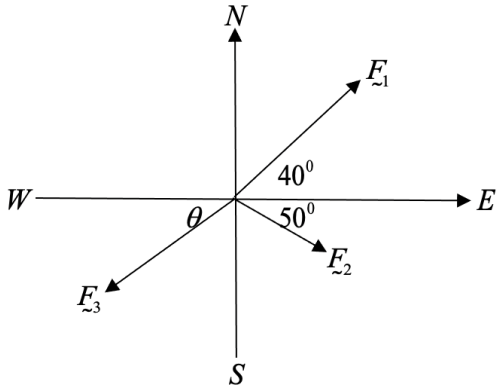
If $F = 50 = 14a + 49 \Rightarrow a = \frac{1}{14}$

If $F = 49 \Rightarrow a = 0$ in limiting equilibrium, or the boxes are on the point of moving.

If $F < 49$ the boxes are not on the point of moving. **C** is false.

Mathematics Questions by Topic
Motion and Force Answer 17 Source: K15SM2Q17

Question 17
A body is on a horizontal smooth plane and acted upon by three forces, $\underset{\sim}{F}_1, \underset{\sim}{F}_2$ and $\underset{\sim}{F}_3$.
A north-south west-east framework is shown.



Given that $|\underset{\sim}{F}_1| = 10$, $|\underset{\sim}{F}_2| = 5$ and let $F_3 = |\underset{\sim}{F}_3|$ and that the body moves in the north direction then

A. $F_3\cos(\theta) = 10.874$ and $F_3\sin(\theta) > 2.598$

B. $F_3\cos(\theta) = 10.874$ and $F_3\sin(\theta) < 2.598$

C. $F_3\sin(\theta) = 2.598$ and $F_3\sin(\theta) < 10.874$

D. $F_3\sin(\theta) = 10.874$ and $F_3\cos(\theta) > 2.598$

E. $F_3\sin(\theta) = 10.874$ and $F_3\cos(\theta) < 2.598$

ANSWER B

Resolving in the east direction $(1)\ \ 10\cos(40^0) + 5\cos(50^0) - F_3\cos(\theta) = 0$
Resolving in the north direction $(2)\ \ 10\sin(40^0) - 5\sin(50^0) - F_3\sin(\theta) > 0$
$(1) \Rightarrow \ \ F_3\cos(\theta) = 10\cos(40^0) + 5\cos(50^0) = 10.874$
$(2) \Rightarrow F_3\sin(\theta) < 10\sin(40^0) - 5\sin(50^0) = 2.598$

Mathematics Questions by Topic
Motion and Force Answer 18 Source: K14SM2Q18

Question 18

A car is moving with constant acceleration has its speed reduced from $3V$ ms^{-1} to V ms^{-1}, over a distance of D m when the driver applies the brakes. The car travels a further distance of S m until it comes to rest. The time T seconds represents the time when the driver applies the brakes until the car comes to rest. Then

A. $D = 8S$ and $T = \dfrac{2(D+S)}{3V}$

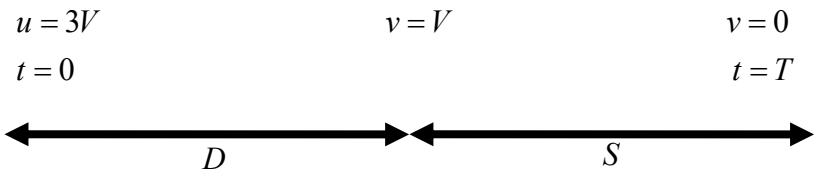
B. $D = 4S$ and $T = \dfrac{2(D+S)}{3V}$

C. $D = 8S$ and $T = \dfrac{S}{V}$

D. $D = 4S$ and $T = \dfrac{S}{V}$

E. $D = 2S$ and $T = \dfrac{D}{2V}$

ANSWER A



use $v^2 = u^2 + 2as$

with $v = V$, $u = 3V$ $s = D$

$V^2 = 9V^2 + 2aD$

$a = -\dfrac{4V^2}{D}$

use $s = \left(\dfrac{u+v}{2}\right)t$

with $v = 0$, $u = 3V$ $s = D + S$ and $t = T$

$D + S = \dfrac{3V}{2} \times T \Rightarrow T = \dfrac{2(D+S)}{3V}$

use $v^2 = u^2 + 2as$

with $v = 0$, $u = V$ $s = S$ and $a = -\dfrac{4V^2}{D}$

$0 = V^2 - 2 \times \dfrac{4V^2}{D} \times S \Rightarrow D = 8S$

Mathematics Questions by Topic
Motion and Force Answer 19 Source: K14SM2Q19

Question 19
A particle of mass *M* kg is on a horizontal table and is connected by a light string to a particle of mass 2 kg hanging vertically at the edge of the table. The coefficient of friction between the table and the mass *M* is equal to $\frac{1}{3}$. Then if

A. $M > 6$ both masses move with constant acceleration.

B. $0 < M < 6$ both masses move with constant acceleration.

C. $0 < M \leq 6$ the system is in limiting equilibrium.

D. $M > 6$ both masses move with constant velocity.

E. $0 < M < 6$ both masses move with constant velocity.

ANSWER B

resolving downwards for the 2 kg mass hanging over the edge of the table

$(1)\quad 2g - T = 2a$

resolving for the mass *M* on the table

$(2)\quad N - Mg = 0$

$(3)\quad T - \mu N = Ma$

$(2) \Rightarrow N = Mg$ into $(3)\ T - \mu Mg = Ma$

adding to eliminate *T*

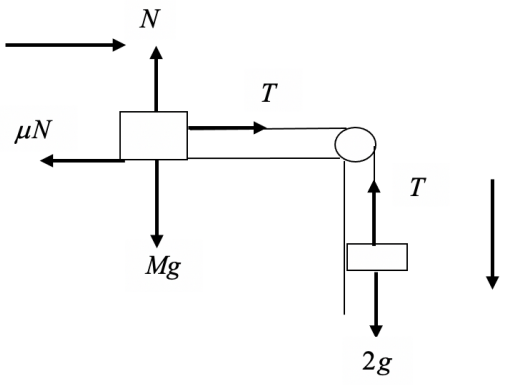
$2g - \mu Mg = (M+2)a \quad \text{but} \quad \mu = \frac{1}{3}$

$2g - \frac{1}{3}Mg = \frac{g(6-M)}{3} = (M+2)a$

$a = \frac{g(6-M)}{3(M+2)}$

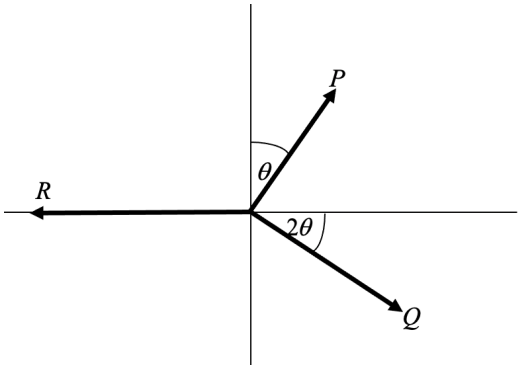
$a > 0 \Rightarrow 0 < M < 6$

$a = 0 \Rightarrow M = 6$



Mathematics Questions by Topic
Motion and Force Answer 20 Source: K14SM2Q20

Question 20
Three coplanar forces of magnitudes *P*, *Q* and *R* newtons act on a particle that is in equilibrium as shown in the diagram below.



Then

A. $Q = R$ and $P = 2R\sin(\theta)$

B. $Q = R$ and $P = 2R\cos(\theta)$

C. $Q = 2P$ and $R = P\sin(\theta)$

D. $P = Q$ and $R = 2P\sin(\theta)$

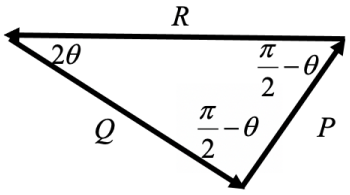
E. $P + Q + R = 0$

ANSWER A

$$\frac{Q}{\sin\left(\frac{\pi}{2}-\theta\right)} = \frac{R}{\sin\left(\frac{\pi}{2}-\theta\right)} = \frac{P}{\sin(2\theta)}$$

$$\frac{Q}{\cos(\theta)} = \frac{R}{\cos(\theta)} = \frac{P}{2\sin(\theta)\cos(\theta)}$$

$Q = R$ and $P = 2R\sin(\theta)$



Alternatively resolving vertically $P\cos(\theta) - Q\sin(2\theta) = 0$

$P\cos(\theta) = 2Q\sin(\theta)\cos(\theta) \Rightarrow P = 2Q\sin(\theta)$ (1)

resolving horizontally $P\sin(\theta) + Q\cos(2\theta) - R = 0$

$P\sin(\theta) + Q\left(1 - 2\sin^2(\theta)\right) = R$ from (1) $P = 2Q\sin(\theta)$

$2Q\sin^2(\theta) + Q - 2Q\sin^2(\theta) = R \Rightarrow Q = R$ and $P = 2R\sin(\theta)$

Mathematics Questions by Topic
Motion and Force Answer 21 Source: K14SM2Q21

Question 21

A particle of mass 10 kg travels in a straight line with velocity $v\ \text{ms}^{-1}$ when its displacement is *x* metres, where $v = 2\log_e\left(\sqrt{x^2+1}+x\right)$ for $x \geq 0$. The maximum force in newtons acting on the particle is closest to

A. 1.5
B. 2.7
C. 20
D. 24
E. 26.5

ANSWER E

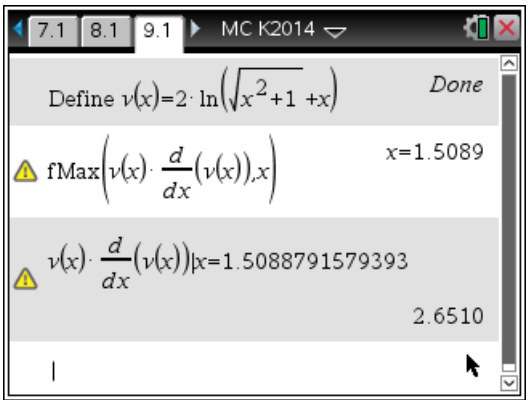
$$v = 2\log_e\left(\sqrt{x^2+1}+x\right)$$

$$\frac{dv}{dx} = \frac{2}{\sqrt{x^2+1}}$$

$$a(x) = v\frac{dv}{dx} = \frac{4\log_e\left(\sqrt{x^2+1}+x\right)}{\sqrt{x^2+1}}$$

$a(x)$ has a maximum when $x = 1.51$

$$F_{\max} = ma = 10 \times a(1.51) = 26.5$$



Mathematics Questions by Topic
Motion and Force Answer 22 Source: K13SM2Q21

Question 22

A particle is acted upon by two forces. One has a magnitude of $\sqrt{2}\,b$ newtons and acts in the direction $S\,45^0\,E$, the other has a magnitude of $\sqrt{2}\,c$ newtons and acts in the direction $N\,45^0\,E$, where *b* and *c* are non-zero real positive constants. The magnitude of the resultant force is equal to

A. $\sqrt{2}(b+c)$

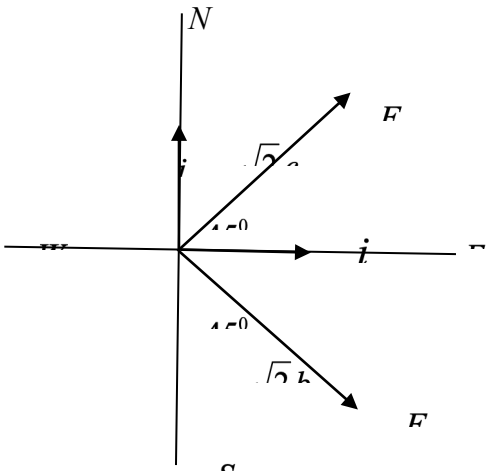
B. $\frac{\sqrt{2}}{2}(b+c)$

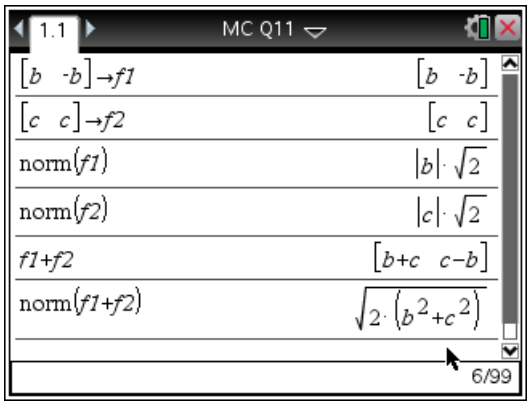
C. $2\sqrt{2\left(b^2+c^2\right)}$

D. $\sqrt{2\left(b^2+c^2\right)}$

E. $2\sqrt{b^2+c^2}$

ANSWER D





$$\underset{\sim}{F_1} = \sqrt{2}\,b\left(\sin\left(45^0\right)\underset{\sim}{i} - \cos\left(45^0\right)\underset{\sim}{j}\right) = b\left(\underset{\sim}{i} - \underset{\sim}{j}\right) \qquad \left|\underset{\sim}{F_1}\right| = \sqrt{2}\,b$$

$$\underset{\sim}{F_2} = \sqrt{2}\,c\left(\sin\left(45^0\right)\underset{\sim}{i} + \cos\left(45^0\right)\underset{\sim}{j}\right) = c\left(\underset{\sim}{i} + \underset{\sim}{j}\right) \qquad \left|\underset{\sim}{F_2}\right| = \sqrt{2}\,c$$

$$\underset{\sim}{F_1} + \underset{\sim}{F_2} = (b+c)\underset{\sim}{i} + (c-b)\underset{\sim}{j}$$

$$\left|\underset{\sim}{F_1} + \underset{\sim}{F_2}\right| = \sqrt{(b+c)^2 + (c-b)^2} = \sqrt{b^2+2bc+c^2+c^2-2bc+b^2}$$

$$= \sqrt{2\left(b^2+c^2\right)}$$

Mathematics Questions by Topic

Motion and Force Answer 23 Source: K13SM2Q12

Question 23

A car of mass *m* kg is travelling on a level roadway. The engine exerts a constant propulsive force of *F* newtons and the total resistance to the motion of the car is kv newtons, where *k* is positive constant and *v* is its speed in m/s. The car moves from rest, and travels a distance of *D* metres until it obtains a speed of *V* m/s, in a time of *T* seconds.

Five students stated some relationships between the constants, *m*, *V*, *k*, *F* , *D* and *T*.

Alan stated that $mV = (F - kV)T$ Ben stated that $2mD = (F - kV)T^2$

Colin stated that $\frac{1}{2}mV^2 = (F - kV)D$ David stated that $D = \int_0^V \frac{mv}{F - kv}dv$

Edward stated that $T = \int_0^V \frac{m}{F - kv}dv$

Then

A. Alan, Ben and Colin are all correct.

B. Alan and Colin are both correct.

C. Only Colin is correct.

D. David and Edward are both correct.

E. Only Edward is correct.

ANSWER D

Resolving the forces horizontally, the equation of motion is $ma = F - kv,$ although, *m* , *V*, *k* , *F* , *D* and *T* are all constants, we cannot use the constant acceleration formulae, since the acceleration is not constant, and depends on the speed. So Alan, Ben and Colin are all incorrect, all their relationships are derived from using the constant acceleration formulae.

Use $a = \frac{dv}{dt}$ then $m\frac{dv}{dt} = F - kv \Rightarrow \frac{dt}{dv} = \frac{m}{F - kv}$ integrating, between $v = 0$ and $v = V$

$\Rightarrow \int_0^T 1\,dt = T = \int_0^V \frac{m}{F - kv}dv$, so that Edward is correct.

Use $a = v\frac{dv}{dx}$ then $mv\frac{dv}{dx} = F - kv \Rightarrow \frac{dx}{dv} = \frac{mv}{F - kv}$ integrating, between $v = 0$ and $v = V$,

$\Rightarrow \int_0^D 1\,dx = D = \int_0^V \frac{mv}{F - kv}dv$, so that David is correct.

Mathematics Questions by Topic
Motion and Force Answer 24 Source: K13SM2Q13

Question 24
A girl of mass 50 kg is standing in a lift. The reaction of the lift floor on the girl is equal to 60 kg-wt. Then the lift is moving

A. with constant speed.

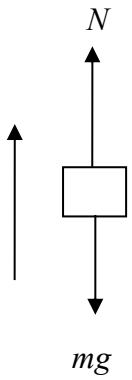
B. down with an acceleration equal to 1.96 ms^{-2}.

C. up with an acceleration equal to 1.96 ms^{-2}.

D. down with an acceleration equal to 0.2 ms^{-2}.

E. up with an acceleration equal to 0.2 ms^{-2}.

ANSWER C



If the lift is moving up, the equation of motion is

$ma = N - mg$

$m = 50 \text{ kg}$ and $N = 60\,\text{kg-wt} = 60g$ newtons

$50a = 60g - 50g = 10g$

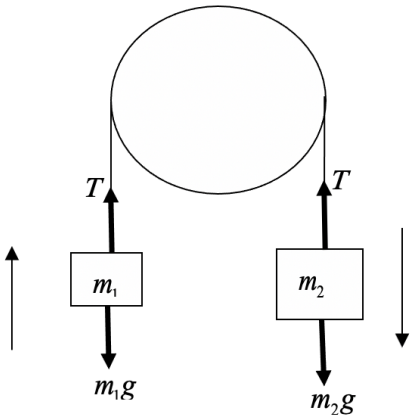
$a = \frac{g}{5} = 1.96 \text{ ms}^{-2}$

C. is correct, the lift moves up with an acceleration equal to 1.96 ms^{-2}.

Mathematics Questions by Topic
Motion and Force Answer 25 Source: K13SM2Q21

Question 25

A light inextensible string passes over a smooth pulley, with particles of masses m_1 and m_2 kg, attached to each end of the string as shown in the diagram.



Which of the following is **false?**

A. If $m_2 = 2m_1$ the mass m_2 moves downwards with an acceleration $\frac{g}{2}$ ms^{-2}.

B. If $m_1 = m_2 = m$ the tension in the string is equal to mg newtons.

C. If $m_1 = m_2$ both masses remain at rest.

D. If $m_2 > m_1$ the mass m_2 moves downwards with an acceleration $\frac{(m_2 - m_1)g}{m_1 + m_2}$ ms^{-2}.

E. If $m_1 \neq m_2$ the tension in the string is equal to $\frac{2m_1m_2}{m_1 + m_2}$ kg-wt.

ANSWER A

If $m_2 > m_1$ the mass m_2 moves downwards, resolving downwards, $(1) \quad m_2g - T = m_2a$ The mass m_1 moves upwards, resolving upwards, $(2) \quad T - m_1g = m_1a$ Solving for *a* and *T* gives	$a = \frac{(m_2 - m_1)g}{m_1 + m_2}$ and $T = \frac{2m_1m_2g}{m_1 + m_2}$ So that **D.** and **E.** are both true. **B.** and **C.** are also true. **If** $m_2 = 2m_1$ **then** $a = \frac{(2m_1 - m_1)g}{m_1 + 2m_1} = \frac{g}{3}$ **A.** is false.

Mathematics Questions by Topic
Motion and Force Answer 26 Source: K13SM2Q22

Question 26

A particle of mass *m* kg is acted upon by a variable force, so that its velocity *v* m/s when the particle is *x* m from the origin is given by $v = e^{cx}$, where *c* is a non-zero real constant. The force acting on the particle when $x = \frac{1}{c}$, in newtons, is

A. mc^2

B. mec

C. me

D. me^2

E. mce^2

ANSWER E

$v = e^{cx} \quad \frac{dv}{dx} = ce^{cx}$

$F = ma = mv\frac{dv}{dx} = mce^{2cx}$ when $x = \frac{1}{c}$

$F = mce^{2c\times\frac{1}{c}} = mce^2$

Mathematics Questions by Topic
Motion and Force Answer 27 Source: K12SM2Q14

Question 27

A body moves in a straight line such that its velocity $v\ \text{ms}^{-1}$ is given by $v(x)=e^{2x}-e^{-2x}$, where *x* metres is its displacement from the origin. The acceleration of the body in ms^{-2} is given by

A. $4\left(e^{4x}-e^{-4x}\right)$

B. $2\left(e^{4x}-e^{-4x}\right)$

C. $e^{4x}-e^{-4x}$

D. $2\left(e^{2x}+e^{-2x}\right)$

E. $-4x$

ANSWER B

$v(x)=e^{2x}-e^{-2x}$

$\dfrac{dv}{dx}=2\left(e^{2x}+e^{-2x}\right)$

$a=v\dfrac{dv}{dx}=2\left(e^{2x}-e^{-2x}\right)\left(e^{2x}+e^{-2x}\right)$

$a(x)=2\left(e^{4x}-e^{-4x}\right)$

alternatively

$v^2(x)=\left(e^{2x}-e^{-2x}\right)^2=e^{4x}-2+e^{-4x}$

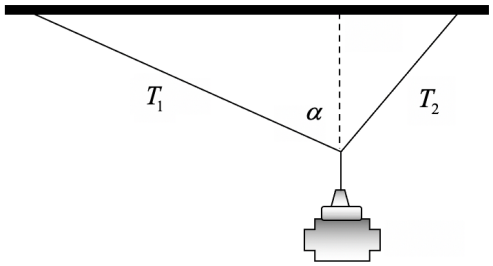
$\dfrac{1}{2}v^2=\dfrac{1}{2}e^{4x}-1+\dfrac{1}{2}e^{-4x}$

$a(x)=\dfrac{d}{dx}\left(\dfrac{1}{2}v^2\right)=2\left(e^{4x}-e^{-4x}\right)$

Mathematics Questions by Topic
Motion and Force Answer 28 Source: K12SM2Q17

Question 28

An engine weighing 5 kg is suspended by two ropes at right angles to one another, which support tensions of T_1 and T_2 newtons. The rope supporting a tension of T_1 makes an angle of α to the vertical as shown in the diagram below.



Then

A. $T_1 = 5\sin(\alpha)$ and $T_2 = 5\cos(\alpha)$

B. $T_1 = 5\cos(\alpha)$ and $T_2 = 5\sin(\alpha)$

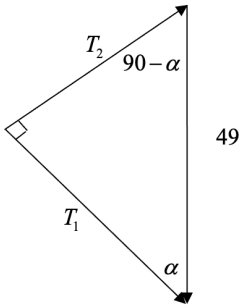
C. $T_1 = 5\tan(\alpha)$ and $T_2 = \dfrac{5}{\tan(\alpha)}$

D. $T_1 = 49\sin(\alpha)$ and $T_2 = 49\cos(\alpha)$

E. $T_1 = 49\cos(\alpha)$ and $T_2 = 49\sin(\alpha)$

ANSWER E

The forces are in newtons, the weight force is $mg = 5 \times 9.8 = 49$ newtons.



By Lami's theorem, $\dfrac{T_1}{\sin(90-\alpha)} = \dfrac{T_2}{\sin(\alpha)} = \dfrac{49}{\sin(90^0)}$

$T_1 = 49\cos(\alpha)$ and $T_2 = 49\sin(\alpha)$

Mathematics Questions by Topic
Motion and Force Answer 29 Source: K12SM2Q20

Question 29

A constant force of 10 newtons acts on a mass of 5 kg initially moving at 1 ms^{-1}. After the mass has moved a distance of 20 metres, the magnitude of the momentum in $kgms^{-1}$, is equal to

A. 9

B. 10

C. 40

D. 45

E. 50

ANSWER D

$F = 10 \text{ newtons} \quad m = 5 \text{ kg} \quad a = \frac{F}{m} \qquad a = 2\,\text{ms}^{-2} \quad u = 1 \ \text{ms}^{-1} \quad s = 20$

$v^2 = u^2 + 2as \ \Rightarrow v^2 = 1 + 2 \times 2 \times 20 = 81 \ \text{ so } \ v = 9 \quad \text{ so } \ p = mv = 5 \times 9 = 45\,\text{kgms}^{-1}$

Mathematics Questions by Topic
Motion and Force Answer 30 Source: K11SM2Q15

Question 30

A hot air balloon is accelerating upwards with an acceleration of 1 m/s^2. At a particular instant it is 250 metres above ground level and rising upwards with a speed of 3 m/s. A small stone falls from the balloon to the ground. Assuming air resistance is negligible, the time taken, for the stone to hit the ground in seconds, is closest to

A. 7.89

B. 7.54

C. 7.46

D. 7.20

E. 7.14

ANSWER C

The stone takes on the initial upwards speed of the balloon, but its acceleration is just due to gravity. Taking upwards as positive and downwards as negative,

$s = -250 \quad u = 3 \quad a = -9.8 \quad t = ? \quad \text{using} \quad s = ut + \frac{1}{2}at^2$

$-250 = 3t - 4.9t^2 \quad \text{solving} \Rightarrow t = 7.46$

Mathematics Questions by Topic
Motion and Force Answer 31 Source: K11SM2Q17

Question 31

A box of mass 10 kg is at rest on a plane inclined at angle of 30^0 to the horizontal.
A force of magnitude 10 kg-wt acting up and parallel to the plane is applied to the box.
For equilibrium to be maintained, the co-efficient of friction between the box and the plane must be

A. at least $\frac{\sqrt{3}}{3}$

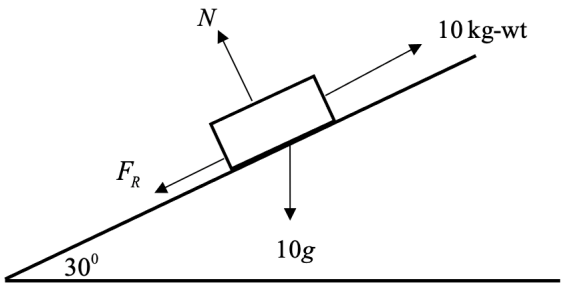
B. less than $\frac{\sqrt{3}}{3}$

C. at least $\frac{g-2}{g\sqrt{3}}$

D. less than $\frac{g-2}{g\sqrt{3}}$

E. at least $5g\sqrt{3}$

ANSWER A



Note that all forces are in newtons.
resolving perpendicular to the plane $N-10g\cos\left(30^0\right)=0 \quad \Rightarrow N=10g\cos\left(30^0\right)=5\sqrt{3}g$
resolving up and parallel to the plane
$10g-10g\sin\left(30^0\right)-F_R=0 \quad \Rightarrow F_R=10g-10g\sin\left(30^0\right)=5g$
$F_R \le \mu N$

$5g \le \mu 5\sqrt{3}g \qquad \Rightarrow \mu \ge \frac{1}{\sqrt{3}}=\frac{\sqrt{3}}{3}$

Mathematics Questions by Topic
Motion and Force Answer 32 Source: K11SM2Q18

Question 32

A body of mass *m* kg moves in a straight line, its velocity is *v* ms^{-1} at a time *t* seconds. The force acting on the body is $f(t)$ newtons. Given that $v = v_1$ when $t = t_1$ and $v = v_2$ when $t = t_2$, it follows that

A. $mv_2 - mv_1 = f(t_2) - f(t_1)$

B. $mv_2 - mv_1 = \int_{t_1}^{t_2} f(t)\,dt$

C. $v_2 - v_1 = m\int_{t_1}^{t_2} f(t)\,dt$

D. $\frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 = f(t_2) - f(t_1)$

E. $\frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 = \int_{t_1}^{t_2} f(t)\,dt$

ANSWER B

By Newton's Law $R = ma$ using $a = \frac{dv}{dt}$ with $R = f(t)$

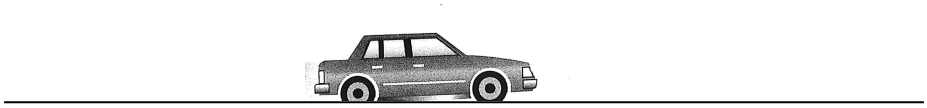
$$f(t) = m\frac{dv}{dt}$$

$$m\int_{v_1}^{v_2} 1.dv = m[v]_{v_1}^{v_2} = mv_2 - mv_1 = \int_{t_1}^{t_2} f(t)\,dt$$

Mathematics Questions by Topic
Motion and Force Answer 33 Source: K11SM2Q19

Question 33

A car of mass *m* kg is travelling on a level roadway. The engine exerts a constant propulsive force of *F* newtons and the total resistance to the motion of the car is kv^3 newtons, where *k* is positive constant and *v* is its speed in m/s. The car moves from rest, the distance travelled in metres until it obtains a speed of *V*, is given by



A. $\dfrac{V^2}{2\left(F-kV^3\right)}$

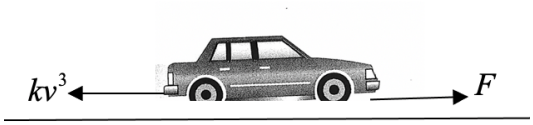
B. $\dfrac{mV^2}{2\left(F-kV^3\right)}$

C. $\dfrac{m}{2}\displaystyle\int_0^V \frac{v^2}{F-kv^3}\,dv$

D. $\displaystyle\int_0^V \frac{mv}{F-kv^3}\,dv$

E. $\displaystyle\int_0^V \frac{v}{F-kv^3}\,dv$

ANSWER D



By Newton's law, the equation of motion is given by

$ma = F - kv^3$, using $a = v\dfrac{dv}{dx}$

$mv\dfrac{dv}{dx} = F - kv^3$ integrating from $v = 0$ to $v = V$

the distance *s*, travelled from rest is given by $s = \displaystyle\int_0^V \frac{mv}{F-kv^3}\,dv$

Mathematics Questions by Topic
Motion and Force Answer 34 Source: K10SM2Q13

Question 34

A particle of mass 5 kg, initially at rest is acted upon by two forces. One force has a magnitude of $5\sqrt{2}$ newtons acting in the north-west direction, the other force has magnitude of 10 newtons acting in the east direction. After two seconds, the magnitude of the momentum of the particle in kg ms^{-1} is equal to

A. $50\sqrt{2}$

B. $25\sqrt{2}$

C. $10\sqrt{2}$

D. $2\left(2-\sqrt{2}\right)$

E. $2\sqrt{2}$

ANSWER C

$m = 5\ kg \qquad \underset{\sim}{F_1} = 10\underset{\sim}{i} \qquad \left|\underset{\sim}{F_1}\right| = 10$

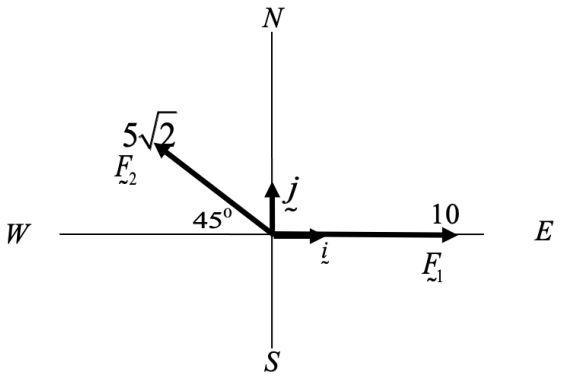
and $\underset{\sim}{F_2} = -5\underset{\sim}{i} + 5\underset{\sim}{j} \qquad \left|\underset{\sim}{F_2}\right| = 5\sqrt{2}$

$\underset{\sim}{F_1} + \underset{\sim}{F_2} = 5\underset{\sim}{i} + 5\underset{\sim}{j}$

$\left|\underset{\sim}{F_1} + \underset{\sim}{F_2}\right| = 5\sqrt{2} = ma = 5a$

$a = \sqrt{2} \qquad u = 0 \qquad t = 2$

using $v = u + at \quad \Rightarrow \quad v = 2\sqrt{2}$



Mathematics Questions by Topic
Motion and Force Answer 35 Source: K10SM2Q17

Question 35

A body of mass *m* kg moves in a straight line. When its displacement is *x* m from the origin, its velocity is *v* ms^{-1} at a time *t* seconds. The force acting on the body is $mf(x)$ newtons. Given that $v = v_0$ when $x = x_0$ and $v = v_1$ when $x = x_1$, it follows that

A. $\frac{1}{2}mv_1^2 - \frac{1}{2}mv_0^2 = m\left[f(x_1) - f(x_0)\right]$

B. $\frac{1}{2}mv_1^2 - \frac{1}{2}mv_0^2 = m\int_{x_0}^{x_1} f(x)\,dx$

C. $v_1 - v_0 = \left[f(x_1) - f(x_0)\right]$

D. $v_1 - v_0 = \int_{x_0}^{x_1} f(x)\,dx$

E. $v_1 = \sqrt{v_0^2 + m\int_{x_0}^{x_1} f(x)\,dx}$

ANSWER B

$$m\ddot{x} = mf(x)$$

$$m\frac{d}{dx}\left(\frac{1}{2}v^2\right) = mf(x)$$

$$m\left[\frac{1}{2}v^2\right]_{v_o}^{v_1} = m\int_{x_0}^{x_1} f(x)\,dx$$

$$\frac{1}{2}mv_1^2 - \frac{1}{2}mv_0^2 = m\int_{x_0}^{x_1} f(x)\,dx$$

Mathematics Questions by Topic
Motion and Force Answer 36 Source: K10SM2Q18

Question 36

An object of mass *m* kg is projected downwards from a point *P*, with an initial speed of of *U* m/s. The object falls under the influence of gravity in a medium which offers resistance proportional to the velocity. Take the initial position as $y=0$ and downwards as the positive direction. If *k* is a positive constant, which of the following most accurately reflects the situation ?

A. $\ddot{y}-k\dot{y}=mg \quad y(0)=0 \quad \dot{y}(0)=U$

B. $\ddot{y}-k\dot{y}=g \quad y(0)=0 \quad \dot{y}(0)=-U$

C. $\ddot{y}+k\dot{y}=mg \quad y(0)=0 \quad \dot{y}(0)=U$

D. $\ddot{y}+k\dot{y}=mg \quad y(0)=0 \quad \dot{y}(0)=-U$

E. $\ddot{y}+k\dot{y}=g \quad y(0)=0 \quad \dot{y}(0)=U$

ANSWER E

motion is downwards, positive direction

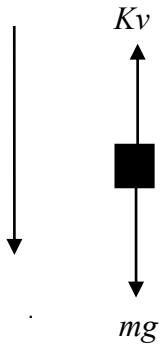
$m\ddot{y}=mg-R \quad$ where $\quad R=Kv=K\dot{y}$

$m\ddot{y}=mg-Kv$

$m\ddot{y}=mg-K\dot{y}$

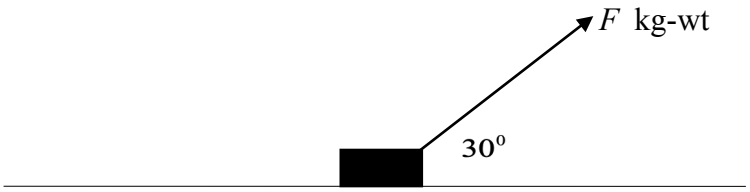
$m\ddot{y}+K\dot{y}=mg \quad$ let $\quad k=\dfrac{K}{m}$

$\ddot{y}+ky=g \quad y(0)=0 \quad \dot{y}(0)=U$



Mathematics Questions by Topic
Motion and Force Answer 37 Source: K10SM2Q21

Question 37



A box of mass 3 kg is on a horizontal plane. A force of magnitude *F* kg-wt acting at an angle of 30^0 to the horizontal is applied to the box. The coefficient of friction between the box and the plane is $\frac{\sqrt{3}}{2}$. Which of the following is true?

A. If $F < 2g$ the box is not on the point of moving.

B. If $F < 2g$ the box moves with constant velocity.

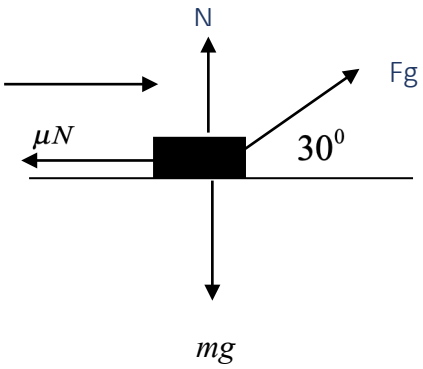
C. If $F = 2$ the box moves with constant acceleration.

D. If $F > 2$ the box moves with constant velocity.

E. If $F > 2$ the box moves with constant acceleration.

ANSWER E

All forces must be in newtons, $m = 3\,\text{kg}$ $\mu = \frac{\sqrt{3}}{2}$



resolving perpendicular to the plane

(1) $N + Fg\sin(30^0) - mg = 0$

$\Rightarrow N = 3g - \frac{Fg}{2}$

resolving parallel to the plane

(2) $Fg\cos(30^0) - \mu N = ma$

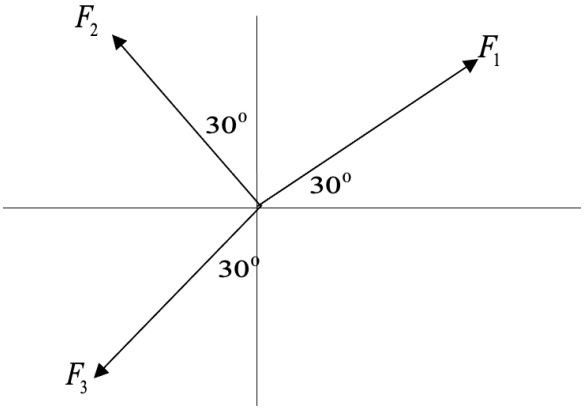
$\frac{Fg\sqrt{3}}{2} - \frac{\sqrt{3}}{2}\left(3g - \frac{Fg}{2}\right) = 3a$

$\Rightarrow \frac{3g\sqrt{3}}{4}(F-2) = 3a$ so if $F > 2$ $\Rightarrow$ $a > 0$

Mathematics Questions by Topic
Motion and Force Answer 38 Source: K9SM2Q11

Question 38

Three co-planar forces, F_1, F_2, F_3 act on a particle in equilibrium as shown in the diagram below.



Then,

A. $F_1 = F_2 = F_3$

B. $3F_2 = \sqrt{3}F_1$ and $F_2 = \frac{2}{3}F_3$

C. $F_1 = \sqrt{3}F_2$ and $F_3 = 2F_2$

D. $\sqrt{3}F_1 = 3F_2$ and $F_2 = \frac{3}{2}F_3$

E. $\sqrt{3}F_3 = 3F_2$ and $F_1 = \frac{3}{2}F_3$

ANSWER C

Resolving horizontally (1) $F_1\cos(30^0) - F_2\sin(30^0) - F_3\sin(30^0) = 0$

Resolving vertically (2) $F_1\sin(30^0) + F_2\cos(30^0) - F_3\cos(30^0) = 0$

$(1) \Rightarrow F_1 = \tan(30^0)(F_2 + F_3) \Rightarrow F_1 = \frac{1}{\sqrt{3}}(F_2 + F_3)$ so that $\sqrt{3}F_1 = F_2 + F_3$

$(2) \Rightarrow \tan(30^0)F_1 = F_3 - F_2 \Rightarrow \frac{\sqrt{3}}{3}F_1 = F_3 - F_2$ so that $\sqrt{3}F_1 = 3(F_3 - F_2)$

$3F_3 - 3F_2 = F_2 + F_3 \Rightarrow F_3 = 2F_2$ and $F_1 = \sqrt{3}F_2$

Mathematics Questions by Topic
Motion and Force Answer 39 Source: K9SM2Q18

Question 39

A parcel of mass 2 kg, is at rest on a rough horizontal table. The coefficient of friction between the parcel and the table is 0.25. A constant horizontal force of 10 newtons is applied to the parcel. Two seconds later the magnitude of the momentum of the parcel in kg m/s is equal to

A. 5.1

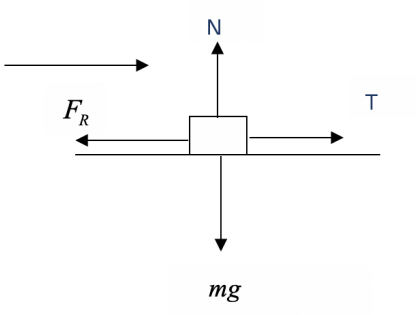
B. 10

C. 10.2

D. 20

E. 186.2

ANSWER C



Let T be the horizontal force applied now $T = 10\text{ N}$ $m = 2\text{kg}$ $\mu = 0.25$
resolving parallel to the plane (1) $T - F_R = ma$ and $F_R = \mu N$
resolving perpendicular to the plane (2) $N - mg = 0$
and from (2) $N = mg$ (1) $a = \frac{1}{m}(T - \mu mg)$
$a = \frac{1}{2}(10 - 0.25\text{x}2\text{x}9.8) = 2.55,$ $u = 0,$ using $v = u + at$
momentum $mv = 2\text{ x }2.55\text{ x }2 = 10.2$ kg m/s

Mathematics Questions by Topic
Motion and Force Answer 40 Source: K9SM2S21

Question 40

A sand bag of mass 9 kg is dropped from a stationary hot-air balloon, which is 150 metres above the ground. Which of the following is true?

A. The sand bag hits the ground after 5.48 seconds, with a speed of 54.78m/s.

B. The sand bag hits the ground after 5.48 seconds, with a speed of 53.68 m/s.

C. The sand bag hits the ground after 5.53 seconds, with a speed of 55.33m/s.

D. The sand bag hits the ground after 5.53 seconds, with a speed of 54.22m/s.

E. The sand bag hits the ground after 5.68 seconds with a speed of 50m/s.

ANSWER D

Using constant acceleration formulae $a=-9.8 \quad u=0 \quad s=-150 \quad t=? \quad v=?$

$$s=ut+\frac{1}{2}at^2 \quad \Rightarrow \quad -150=0-\frac{1}{2}\text{x}9.8t^2 \quad \Rightarrow t=\sqrt{\frac{2\text{x}150}{9.8}}=5.533$$

$$v=u+at \quad \Rightarrow \quad v=0-9.8\text{x}5.533=-54.22$$

The sandbag hits the ground after 5.533 seconds, with a speed of 54.22 m/s.

Mathematics Questions by Topic
Motion and Force Answer 41 Source: K9SM2S22

Question 41

Two boxes of masses 2 kg and 3 kg are connected by a light horizontal string and are on a horizontal table, as shown in the diagram below. The coefficient of friction between both boxes and the table is $\frac{1}{7}$. The 3 kg box is pulled by a force of F, parallel to the table.

Which of the following is true?

A. If $F > 7$ newtons, the boxes move with constant acceleration.

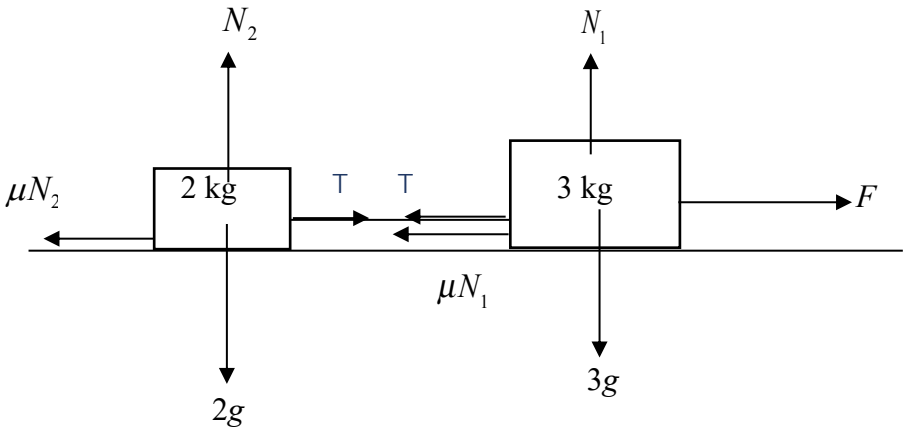
B. If $5 < F < 7$ newtons, the boxes are on the point of moving.

C. If $F = 7$ newtons, the boxes move with constant velocity.

D. If $F > 7\,\text{kg-wt}$, the boxes move with constant velocity.

E. If $F = 7\,\text{kg-wt}$, the boxes are not on the point of moving.

ANSWER A



Resolving horizontally around the 3 kg mass, $(1)\ F - T - \mu N_1 = 3a$

Resolving vertically around the 3 kg mass, $(2)\ N_1 - 3g = 0 \Rightarrow N_1 = 3g$

Resolving horizontally around the 2 kg mass, $(3)\ T - \mu N_2 = 2a$

Resolving vertically around the 2 kg mass, $(4)\ N_2 - 2g = 0 \Rightarrow N_2 = 2g$

(1) becomes $F - T - 3\mu g = 3a$

(3) becomes $T - 2\mu g = 2a$ adding to eliminate the tension T

$F - 5\mu g = 5a$ but $\mu = \frac{1}{7}$ $g = 9.8$ so that $F - 7 = 5a$

If $F > 7$ newtons then $a > 0$, the boxes move with constant acceleration.

All other options are false.

Mathematics Questions by Topic
Motion and Force Answer 42 Source: K8SM2SQ13

Question 42

A box of mass 20 kg is at rest on a horizontal plane. A force of magnitude 10 kg-wt acting at an angle of 30^0 to the horizontal is applied to the block. For equilibrium to be maintained, the coefficient of friction between the box and the plane must be

A. at least $\frac{\sqrt{3}}{3}$

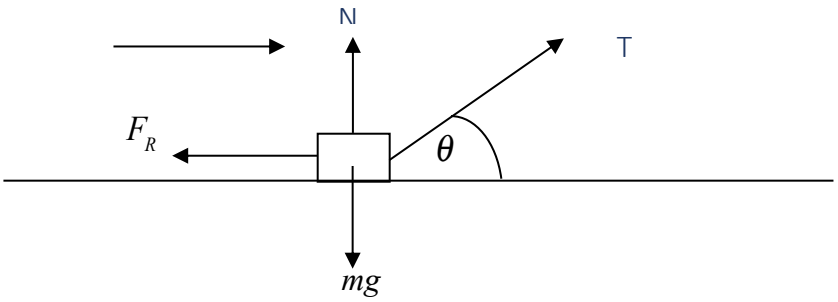
B. less than $\frac{\sqrt{3}}{3}$

C. at least $\frac{\sqrt{3}}{4}$

D. at least $\frac{\sqrt{3}}{4g}$

E. less than $\frac{\sqrt{3}}{4g}$

ANSWER A



$T = 10g$ newtons $\theta = 30^0$ $m = 20$ kg $\mu = ?$

resolving parallel to the plane (1) $T\cos(\theta) - F_R = 0$

resolving perpendicular to the plane (2) $T\sin(\theta) + N - mg = 0$

from (1) $F_R = T\cos(\theta) = 10g \times \frac{\sqrt{3}}{2} = 5\sqrt{3}\,g$

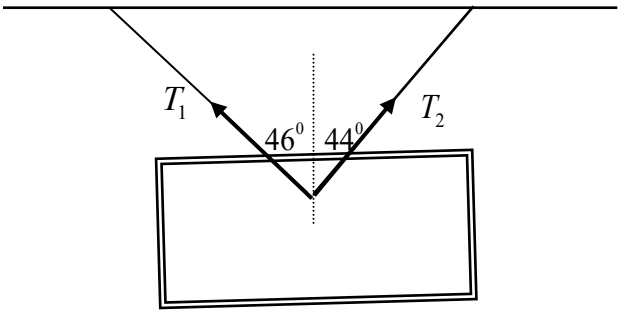
from (2) $N = mg - T\sin(\theta) = 20g - 10g\sin(30^0) = 15g$

for equilibrium to be maintained, $F_R \le \mu N$ so that $5\sqrt{3}\,g \le 15\mu g \quad \Rightarrow \mu \ge \frac{\sqrt{3}}{3}$

Mathematics Questions by Topic
Motion and Force Answer 43 Source: K8SM2SQ14

Question 43

A painting of mass one kilogram is to be hung on a wall using two light strings. Unfortunately the painting is not quite horizontal. One string makes an angle of 46^0 with the vertical and has a tension of magnitude T_1 newtons. The other string makes an angle of 44^0 with the vertical and has a tension of magnitude T_2 newtons, as shown in the diagram below.



Which of the following is true?

A. $\frac{T_1}{T_2} = \tan\left(44^0\right)$

B. $\frac{T_1}{T_2} = \tan\left(46^0\right)$

C. $T_1 + T_2 = g$

D. $T_1^2 + T_2^2 = g^2$

E. $T_1 = T_2$

ANSWER A

resolving horizontally gives

$$T_1 \sin\left(46^0\right) = T_2 \sin\left(44^0\right) \quad \Rightarrow \quad \frac{T_1}{T_2} = \frac{\sin\left(44^0\right)}{\sin\left(46^0\right)} = \frac{\sin\left(44^0\right)}{\cos\left(44^0\right)} = \tan\left(44^0\right)$$

Mathematics Questions by Topic
Motion and Force Answer 44 Source: K8SM2SQ18

Question 44

A hot air balloon is accelerating vertically upwards with an acceleration of 1 m/s^2. A stone is dropped from the balloon when it is *h* metres above the ground. The stone strikes the ground 8 seconds later. Assuming the air resistance is negligible, the value of *h* is closest to

A. 282.

B. 290.

C. 314.

D. 322.

E. 346.

ANSWER C

Using constant acceleration formulae $a = -9.8 \quad u = 0 \quad t = 8 \quad s = ?$

$s = ut + \frac{1}{2}at^2 \qquad s = 0 - \frac{1}{2} \text{x } 9.8 \text{ x } 8^2 = -313.6$

The height *h* is 313 metres.

The stone hits the ground 314 metres below the initial point.

Mathematics Questions by Topic
Motion and Force Answer 45 Source: K7SM2SQ16

Question 45

A particle travels in a straight line with velocity *v* at a time *t* and its displacement is *x*.
If $v^2 = 9x$ for $x > 0$, then the acceleration of the particle is given by

A. $\frac{2x}{3}$

B. 4.5

C. $2\sqrt{x^3}$

D. $6x^2$

E. $\frac{3}{2\sqrt{x}}$

ANSWER B

$v^2 = 9x$ for $x > 0$,
differentiating implicitly with respect to *x*, gives

$$2v\frac{dv}{dx} = 9$$

so that $a = v\frac{dv}{dx} = \frac{9}{2} = 4.5$

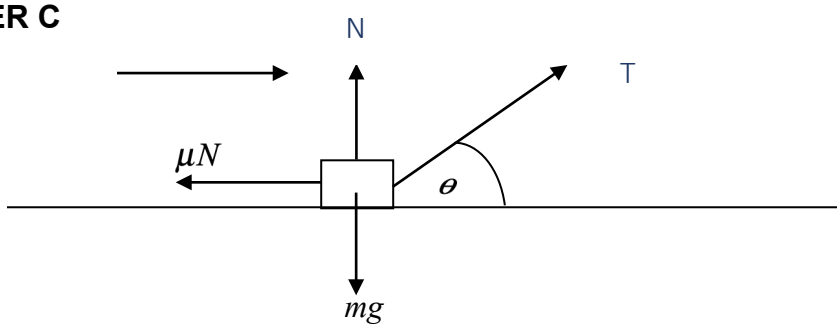
Mathematics Questions by Topic
Motion and Force Answer 46 Source: K7SM2S17

Question 46

A box of mass 10 kg is on a horizontal plane. A rope makes an angle of θ^0 with the horizontal and exerts a tension of 30 newtons. If the coefficient of friction between the block and the surface is 0.2, which one of the following values of θ produces the largest acceleration of the block?

A. $\theta = 0$
B. $\theta = 5$
C. $\theta = 10$
D. $\theta = 15$
E. $\theta = 20$

ANSWER C



resolving parallel to the plane (1) $T\cos(\theta) - \mu N = ma$

resolving perpendicular to the plane (2) $T\sin(\theta) + N - mg = 0$

to find *a* we need to eliminate *N*

from (2) $N = mg - T\sin(\theta)$ substituting into (1) gives

$$T\cos(\theta) - \mu\left(mg - T\sin(\theta)\right) = ma$$

$$ma = T\cos(\theta) - \mu mg + \mu T\sin(\theta)$$

$$ma = T\left(\cos(\theta) + \mu\sin(\theta)\right) - \mu mg$$

$$a = \frac{T}{m}\left[\cos(\theta) + \mu\sin(\theta)\right] - \mu g$$

now when $T = 30\,N$ $m = 10\,\text{kg}$ $\mu = 0.2$ $g = 9{,}8$ $a = ?$

$a = 3\left[\cos(\theta) + 0.2\sin(\theta)\right] - 1.96$, checking each alternative

A. $\theta = 0 \Rightarrow a = 1.04\,\text{m/s}^2$

B. $\theta = 5 \Rightarrow a = 1.08\,\text{m/s}^2$

C. $\theta = 10 \Rightarrow a = 1.1\,\text{m/s}^2$

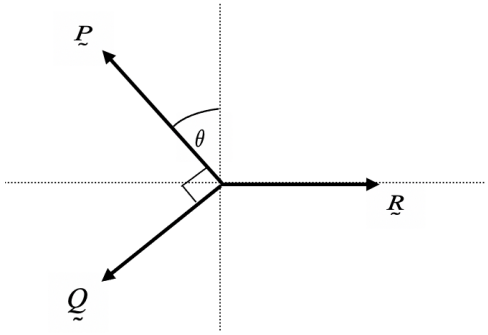
D. $\theta = 15 \Rightarrow a = 1.09\,\text{m/s}^2$

E. $\theta = 20 \Rightarrow a = 1.06\,\text{m/s}^2$

Mathematics Questions by Topic
Motion and Force Answer 47 Source: K7SM2S18

Question 47

The following diagram shows a particle in equilibrium under the action of three concurrent coplanar forces $\underset{\sim}{P}$, $\underset{\sim}{Q}$ and $\underset{\sim}{R}$. The forces $\underset{\sim}{P}$, $\underset{\sim}{Q}$ and $\underset{\sim}{R}$ have magnitudes of P, Q and R respectively.



Which one of the following statements is **not** correct?

A. $P\text{cosec}(\theta) = Q\sec(\theta)$

B. $R^2 = P^2 + Q^2$

C. $R = P\sin(\theta) + Q\cos(\theta)$

D. $\cot(\theta) = \dfrac{P}{Q}$

E. $\underset{\sim}{P} + \underset{\sim}{Q} + \underset{\sim}{R} = \underset{\sim}{0}$

ANSWER D

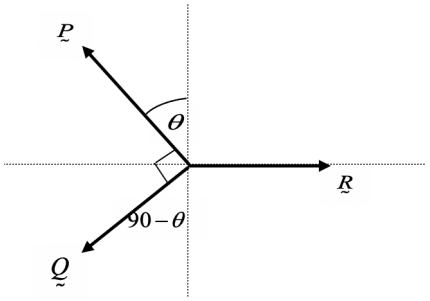
A. resolving vertically

$$P\cos(\theta) - Q\cos(90-\theta) = 0$$

$$P\cos(\theta) = Q\sin(\theta)$$

$$\frac{P}{\sin(\theta)} = \frac{Q}{\cos(\theta)}$$

$$P\text{cosec}(\theta) = Q\sec(\theta) \text{ is true}$$



B. $R^2 = P^2 + Q^2$ is true

C. resolving horizontally

$$R - P\sin(\theta) - Q\sin(90-\theta) = 0$$

$$R = P\sin(\theta) + Q\cos(\theta) \quad \text{is true}$$

D. $P\cos(\theta) = Q\sin(\theta) \Rightarrow \dfrac{P}{Q} = \dfrac{\sin(\theta)}{\cos(\theta)} = \tan(\theta)$ $\cot(\theta) = \dfrac{Q}{P}$ **D.** is false

E. $\underset{\sim}{P} + \underset{\sim}{Q} + \underset{\sim}{R} = \underset{\sim}{0}$ is true

Mathematics Questions by Topic
Motion and Force Answer 48 Source: K7SM2S21

Question 48

A light inextensible string passes over a smooth pulley. Particles of masses m_1 and m_2 are attached to each end of the string as shown in the diagram. If the mass m_2 accelerates downwards at $\frac{g}{5}\ \text{m/s}^2$, then the ratio $\frac{m_2}{m_1}$ is equal to

A. 1

B. $\frac{3}{2}$

C. $\frac{2}{3}$

D. 5

E. $\frac{5}{4}$

ANSWER B

Consider the mass m_2 moving downwards, resolving downwards,

$(1)\qquad m_2 g - T = m_2 a$

Consider the mass m_1 moving upwards, resolving upwards,

$(2)\qquad T - m_1 g = m_1 a$

to solve for *a* add the two equations to eliminate *T*

$m_2 g - m_1 g = m_2 a + m_1 a$

so that $\qquad (m_2 - m_1) g = (m_1 + m_2) a$

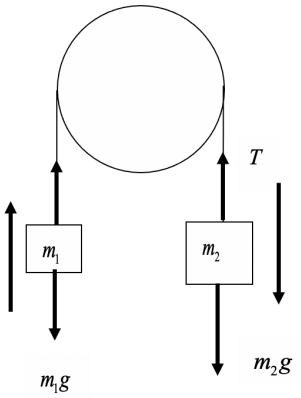
$a = \dfrac{(m_2 - m_1) g}{m_1 + m_2} = \dfrac{g}{5}$ and

$\dfrac{m_2 - m_1}{m_1 + m_2} = \dfrac{1}{5}$

$\dfrac{\frac{m_2}{m_1} - 1}{1 + \frac{m_2}{m_1}} = \dfrac{1}{5}$ let $\alpha = \dfrac{m_2}{m_1}$

$\dfrac{\alpha - 1}{\alpha + 1} = \dfrac{1}{5}$ $\qquad 5(\alpha - 1) = 5\alpha - 5 = \alpha + 1$ $\qquad 4\alpha = 6$

$\alpha = \dfrac{3}{2}$



Mathematics Questions by Topic
Motion and Force Answer 49 Source: K5SM1S25

Question 49

A suitcase of mass 12 kilograms rests on a rough, level ground. The suitcase is pulled with a force of magnitude *P* newtons acting at an angle of 30° to the horizontal. The suitcase is just on the point of sliding along the ground. If the coefficient of friction between the suitcase and the plane is 0.25, then *P* is closest to

A. 58.8

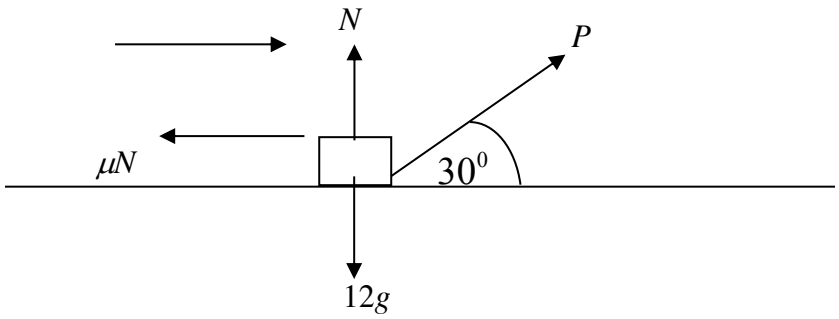
B. 29.67

C. 39.67

D. 3.03

E. 33.95

ANSWER B



resolving parallel to the plane (1) $P\cos\left(30^0\right)-0.25N=0$

resolving perpendicular to the plane (2) $P\sin 30^0+N-12g=0$

from (2) $N=12g-P\sin\left(30^0\right)$ substituting into (1) gives

$$P\cos\left(30^0\right)-0.25\left(12g-P\sin\left(30^0\right)\right)=0$$

$$P\left(\cos\left(30^0\right)+0.25\sin\left(30^0\right)\right)=0.25\text{x}12g$$

$$P=\frac{3g}{\cos\left(30^0\right)+0.25\sin\left(30^0\right)}=29.67 \text{ newton}$$

Mathematics Questions by Topic
Motion and Force Answer 50 Source: K5SM1S29

Question 50

A block of mass m kg is lying on a smooth horizontal table and is joined by a light inextensible string to a another block of mass of $2m$ kg hanging vertically. This string passes over a smooth pulley at the edge of the table. When the system is released from rest, the acceleration of the blocks in m/s^2 is given by

A. $\frac{2}{3}$

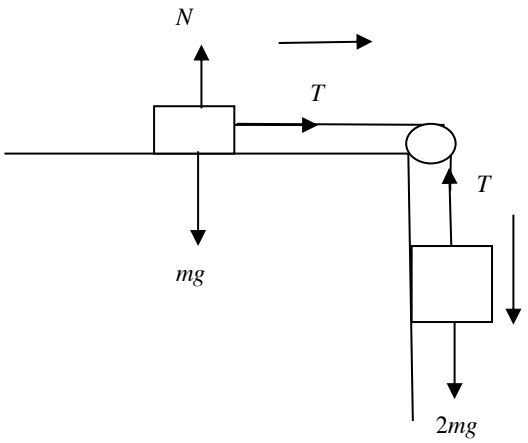
B. $\frac{2g}{3}$

C. 1

D. $2g$

E. g

ANSWER B



resolving using Newton's 2nd law

$(1)\ \ 2mg - T = 2ma$

$(2)\ \ T = ma$ substituting into (1)

$2mg - ma = 2ma$

$3ma = 2mg$

$a = \frac{2g}{3}$

End of
MATHEMATICS QUESTIONS BY TOPICS
MOTION AND FORCE
Answers to 50 Multiple Choice Questions

Mathematics Questions by Topics

Motion and Force – Multiple Choice Summary of Answers

Q	Answer	Q	Answer
1	C	26	E
2	E	27	B
3	E	28	E
4	B	29	D
5	E	30	C
6	B	31	A
7	C	32	B
8	D	33	D
9	A	34	C
10	C	35	B
11	E	36	E
12	C	37	E
13	D	38	C
14	E	39	C
15	A	40	D
16	C	41	A
17	B	42	A
18	A	43	A
19	B	44	C
20	A	45	B
21	E	46	C
22	D	47	D
23	D	48	B
24	C	49	B
25	A	50	B

Distribution: A 9 B 11 C 12 D 8 E 10

Curriculum References

The mathematics content of **Mathematics Questions by Topics** is based on the curriculum references in the links below.

Curriculum	URL
Australia	https://bit.ly/EssentialMaths https://bit.ly/AustralianGeneralMaths https://bit.ly/MathsMethods https://bit.ly/SpecialistMaths
ACT	https://bit.ly/ACTMathematics
New South Wales	https://bit.ly/NSWMathematics
NT	https://bit.ly/NTMathematics
Queensland	https://bit.ly/QueenslandMathematics
South Australia	https://bit.ly/SAMathematics
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