STEP BY STEP SOLUTION TO UTME PHYSICS QUESTION FROM 2001 – 2013 BASED ON TOPICS

KINEMATICS AND DYNAMICS

Question 1

A body weighing 80N stands in an elevator that is about to move. The force exerted by the floor on the body as the elevator moves upward with an acceleration of $5ms^{-1}$ {2002}

A. 40 N B. 80 N C. 120N D. 160N

Solution

The floor will exert an upward floor while the body will exert a downward force (since weight is always directed toward the centre of the earth).

Mg = 80

M = $\frac{80}{g}$

M = 8kg

T – mg = ma

T – 80 = 40

T = 40 + 80

T = 120N

C is the correct option

Question 2

If an object just begins to slide on a surface inclined at 30^{o} to the horizontal, the coefficient of friction is

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

{2003}

Solution

$$\mu = tan\theta$$

$$\mu = coefficient\ of\ friction$$

$$\mu = \tan 30$$

$$\mu = \frac{1}{\sqrt{3}}$$

D is the correct option

Question 3

A force of 100N is used to kick a football of mass 0.8kg. Find the velocity with which the ball moves if it takes 0.8s to be kicked. {2003}

A. $32ms^{-1}$ B. $50ms^{-1}$ C. $64ms^{-1}$ D. $100ms^{-1}$

Solution

Net force = rate of change of momentum

$$f = \frac{m(v-u)}{t}$$

$$100 = \frac{0.8(v-0)}{0.8}$$

V = $100ms^{-1}$

D is the correct answer

Question 4

A 100kg box is pushed along a road with a force of 500N. If the box moves with a uniform velocity, the coefficient of friction between the box and the road is{2004}

A. 0.5 B. 0.4 C. 1.0 D. 0.8

Solution

Since the box moved with a uniform velocity, it implies no net force

i.e.

$$f - \mu mg = 0$$

$$\mu = \frac{f}{mg}$$

$$\mu = \frac{500}{100 \times 10}$$

$$\mu = 0.5$$

A is the correct answer

Question 5

A motorcyclist traveling at $30ms^{-1}$ starts to apply his brakes when he is 50m from the traffic light that had just turned red. If he reached the traffic light, his deceleration is{2005}

A. $18\ ms^{-2}$ B. $10\ ms^{-2}$ C. $9\ ms^{-2}$ D. $5\ ms^{-2}$

Solution

Out of the Newton's equations of motion, the most appropriate equation for the above question is the equation below

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

U = 30, v = o, s = 50

$$0^2 = 30^2 + 2a \times 50$$

0 = 900 + 100a

$$a = -\frac{900}{100}$$

$$a = -9ms^{-2}$$

The negative sign shows it is decelerating
C is the correct option

Question 6

An object is projected from a ground with a velocity of $40ms^{-1}$ at an angle of 30^o to the horizontal. The time of flight is

A. 16s B. 10s C. 8s D. 4s

[g = $10ms^{-2}$]
Solution

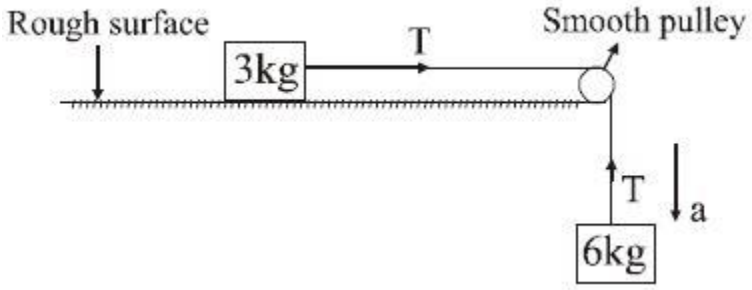
$$T = \frac{2usin\theta}{g}$$

T is the time of flight

$$T = \frac{2 \times 40 \times sin30}{10}$$

T = 4s
D is the correct answer

Question 7



In the figure above, the coefficient of static friction is 0.5. If the tension in the string is T, the acceleration of the system in motion is {2005}

A. 3 ms^{-2} B. 5 ms^{-2} C. 9 ms^{-2} D. 15 ms^{-2}

[g = 10 ms^{-2}]
Solution

Let

$$m_1 = 3kg$$

$$m_2 = 6kg$$

$$m_2g - \mu m_1g = (m_1 + m_2)a$$

$$6g - 0.5 \times 3g = (3 + 6)a$$

4.5g = 9a

$$a = \frac{4.5 \times 10}{9}$$
$$a = 5ms^{-2}$$

B is the correct option

Question 8

What is the acceleration between two points on a velocity-time graph which has coordinates (10s, 15m s^{-1}) and (20s, 35m s^{-1})? {2009}

A. 1.75ms^{-2} B. 3.50ms^{-2} C. 1.00ms^{-2} D. 2.00ms^{-2}

Solution

$$a = \frac{v_2 - v_1}{t_2 - t_1}$$
$$a = \frac{35 - 15}{20 - 10}$$
$$a = \frac{20}{10}$$
$$a = 2ms^{-2}$$

D is the correct option

Question 9

A car accelerates uniformly from rest at 4ms^{-2}. How far will it travel in the fifth complete second? {2009}

A. 100m B. 50m C. 32m D. 18m

Solution

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

First calculate the distance covered in 5s and 4s

In 5s,

$$s = \frac{1}{2} \times 4 \times 5^2 = 50m$$

In 4s

$$s = \frac{1}{2} \times 4 \times 4^2 = 32m$$

In fifth seconds = 50 – 32 = 18m

D is the correct option

Question 10

A body of mass 12kg travelling at 4.2ms^{-1} collides with a second body of mass 18kg at rest. Calculate their common velocity if the two bodies coalesce after collision. {2009}

A. 1.5ms^{-1} B. 1.4ms^{-1} C. 2.1ms^{-1} D. 1.7ms^{-1}

Solution

$$m_1u_1 - m_2u_2 = (m_1 + m_2)v$$
$$12 \times 4.2 - 18 \times 0 = (12 + 18)v$$
$$50.4 = 30v$$

$$v = \frac{50.4}{30}$$
$$v = 1.7ms^{-1}$$

D is the correct option

Question 11

A bullet fired vertically upward from a gun held 2.0m above the ground reaches its maximum height in 4.0 s. calculate its initial velocity. {2009}

A. $10ms^{-1}$ B. $8ms^{-1}$ C. $40ms^{-1}$ D. $20ms^{-1}$

[g = $10ms^{-2}$]

Solution

$$v = u - at$$
$$0 = u - 10 \times 4$$
$$u = 40ms^{-1}$$

C is the correct option

Question 12

An object of mass 80kg is pulled on a horizontal rough ground by a force of 500N. Find the coefficient of static friction. {2009}

A. 0.8 B. 0.4 C. 1.0 D. 0.6

[g = $10ms^{-2}$]

Solution

$$\mu = \frac{F}{mg}$$

$$\mu = \frac{500}{80 \times 10}$$
$$\mu = 0.6$$

D is the correct option

Question 13

Two cars moving in the same direction have speeds of $100kmh^{-1}$ and $130kmh^{-1}$. What is the velocity of the faster car as measured by an observer in the slower car? {2010}

A. $130kmh^{-1}$ B. $230kmh^{-1}$ C. $200kmh^{-1}$ D. $30kmh^{-1}$

Solution

You are to calculate the relative speed

$$u_2 - u_1 = 130 - 100 = 30kmh^{-1}$$

D is the correct option

Question 14

A car moves with an initial velocity of $25ms^{-1}$ and reaches a velocity of $45ms^{-1}$ in 10s. What is the acceleration of the car?{2010}

A. $5ms^{-1}$ B. $25ms^{-1}$ C. $20ms^{-1}$ D. $2ms^{-1}$

Solution

$$v = u + at$$
$$45 = 25 + 10a$$
$$10a = 20$$
$$a = 2ms^{-2}$$

D is the correct option

Question 15

Two balls X and Y weighing 5g and 50kg respectively were thrown up vertically at the same time with a velocity of 100ms^{-1}. How will their positions be one second later? {2011}

A. X and Y will both be 500m from the point of throw

B. X and Y will be 500m from each other

C. Y will be 500 m ahead of X

D. X will be 500m ahead of Y.

Solution

The distance covered after one second

Question 5

$$v^2 = u^2 - 2as$$
$$0^2 = 100^2 - 2 \times 10 \times s$$
$$s = \frac{10000}{20}$$

S = 500m

The position the two balls will be from the point of throw is independent on their mass.

A is the correct option

Question 16

If it takes an object 3s to fall freely to the ground from a certain height, what is the distance covered by the object?

A. 60 m B. 90 m C. 30 m D. 45 m.

[g = 10ms^{-2}]

Solution

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

Initial velocity = 0

$$s = 0 \times 3 + \frac{1}{2} \times 10 \times 3^2$$

S = 45m

D is the correct option

Question 17
Calculate the total distance covered by a train before coming to rest if its initial speed is $30ms^{-1}$ with a constant retardation of $0.1ms^{-2}$. {2012}
A. 5500m
B. 4500m
C. 4200m
D. 3000m.

Solution

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

V = 0
U =$30ms^{-1}$
a=$-0.1ms^{-2}$
The a is negative because the motion is retarding i.e. deceleration

$$0^2 = 30^2 + 2 \times -0.1 \times s$$
$$-0.2s = -900$$
$$s = \frac{-900}{-0.2}$$

S = 4500 m
B is the correct option

Question 18
A car starts from rest and moves with a uniform acceleration of $30ms^{-2}$ for 20s. Calculate the distance covered at the end of the motion.{2012}
A. 6km
B. 12km
C. 18km
D. 24km.
Solution

$$s = \frac{1}{2}at^2$$
$$s = \frac{1}{2} \times 30 \times 20^2$$

S = 6000m = 6km
A is the correct option

Question 19
An object of mass 20kg slides down an inclined plane at an angle of 30^o to the horizontal. The coefficient of static friction is {2012}
A. 0.2 B. 0.3 C. 0.5 D. 0.6
[g = $10ms^{-2}$]

Solution

$$\mu = tan\theta$$

$$\mu = coefficient\ of\ friction$$

$$\mu = \tan 30$$
$$\mu = 0.577 = 0.6$$

D is the correct answer

Question 20

A train with an initial velocity of $20ms^{-1}$ is subjected to a uniform deceleration of $2ms^{-2}$. The time required to bring the train to a complete halt is

A. 40s B. 5s C. 10s D. 20s

Solution

$$v = u + at$$

V = 0

U = 20

a= -2

$$0 = 20 - 2t$$
$$t = \frac{20}{2}$$
$$t = 10s$$

C is the correct option

Question 21

Calculate the apparent weight loss of a man weighing 70kg in an elevator moving downwards with an acceleration of $1.5ms^{-2}$. {2013}

A. 105N B. 686N C. 595N D. 581N

Solution

The apparent weight loss = ma = 70 * 1.5 = 105N

A is the correct option

Question 22

The coefficient of friction between two perfectly smooth surface is {2013}

A. Zero B. Infinity C. One D. Half

Solution

$$The\ coefficient\ of\ friction\ between\ two\ perfectly\ smooth\ surface\ is\ zero$$

A is the correct option

CIRCULAR MOTION: PERIODIC MOTION

Question 1

A particle in circular motion performs 30 oscillations in 6 seconds. Its angular velocity is {2002}
A. 5 rad s^{-1} B. 6 rad s^{-1} C. 5πrad s^{-1} D. 10πrad s^{-1}
Solution

$$\omega = 2\pi f$$
$$\omega = 2\pi \times \frac{30}{6}$$
$$\omega = 10\pi\ rads^{-1}$$

D is the correct answer

Question 2

A car of mass 1500 kg goes round a circular curve of radius 50m at a speed of 40ms^{-1}. The magnitude of the centripetal force on the car is {2007}
A. 1.2 x 10^2N B. 1.2 x 10^3N C. 4.8 x 10^3N D. 4.8 x 10^4N
Solution

$$f = m\omega^2 r = m\frac{v^2}{r}$$
$$f = 1500 \times \frac{40^2}{50}$$
$$f = 48000N$$
$$f = 4.8 \times 10^4 N$$

D is the correct option

Question 3

A force F is required to keep a 5kg mass moving round a cycle of radius 3.5m at a speed of 7ms^{-1}. What is the speed, if the force is tripled?{2008}
A. 4.0ms^{-1} B. 6.6ms^{-1} C. 12.1ms^{-1} D. 21.0ms^{-1}
Solution

$$f = m\frac{v^2}{r}$$

Keeping the mass and the radius of the ball constant, since the same ball is being used

$$\frac{f}{v^2} = \frac{m}{r}$$

So the relation will now be,

$$\frac{f_1}{{v_1}^2} = \frac{f_2}{{v_2}^2}$$

From the question,

$$f_2 = 3f_1$$

Substitute

$$\frac{f_1}{7^2} = \frac{3f_1}{{v_2}^2}$$

$${v_2}^2 = 49 \times 3$$
$${v_2}^2 = 147$$

Find the square root of both sides

$$v_2 = 12.1ms^{-1}$$

C is the correct option

Question 4

If a wheel 1.2m in a diameter rotates at one revolution per second, calculate the velocity of the wheel.{2008}

A. 3.6ms^{-1} B. 3.8ms^{-1} C. 4.0ms^{-1} D. 7.5ms^{-1}

Solution

Frequency = one revolution per second, since frequency is number of oscillation per unit time.

$$\omega = 2\pi f$$

$$\omega = 2 \times 3.142 \times 1 = 6.284\, rads^{-1}$$
$$v = \omega r$$
$$radius = \frac{diameter}{2} = \frac{1.2}{2} = 0.6m$$
$$v = 6.284 \times 0.6 = 3.77 = 3.8ms^{-1}$$

B is the correct answer

Question 5

What is the frequency of vibration if the balance wheel of a wristwatch makes 90 revolutions in 25s?{2008}

A. 0.01Hz B. 0.04Hz C. 2.27Hz D. 3.60Hz

Solution

$$frequency = \frac{no\ of\ oscillation}{unit\ time} = \frac{90}{25} = 3.6Hz$$

D is the correct option

Question 6

An object of mass 2kg moves with a velocity of 10ms^{-1} round a circle of radius 4m. Calculate the centripetal force on the object. {2011}

A. 40 N B. 25 N C. 100 N D. 50 N

Solution

$$f = m\frac{v^2}{r}$$

$$f = 2 \times \frac{10^2}{50}$$

$$f = 40N$$

A is the correct option

Question 7

An object moves in a circular path of radius 0.5m with a speed of $1ms^{-1}$. What is its angular velocity?{2012}

A. 8 $rads^{-1}$ B. 4 $rads^{-1}$ C. 2 $rads^{-1}$ D. 1 $rads^{-1}$

Solution

$$\omega = \frac{v}{r}$$

$$\omega = \frac{1}{0.5} = 2rads^{-1}$$

C is the correct option

Question 8

A simple pendulum of length 0.4m has a period 2s. What is the period of a similar pendulum of length 0.8m at the same place?{2013}

A. $\sqrt{2}s$ B. 8s C. 4s D. $2\sqrt{2}s$

Solution

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Since the question says similar pendulum, that implies 2π and g will be constant. Squaring the equation and making some arrangement,

$$\frac{T^2}{l} = \frac{4\pi^2}{g}$$

Therefore,

$$\frac{{T_1}^2}{l_1} = \frac{{T_2}^2}{l_2}$$

$$\frac{2^2}{0.4} = \frac{{T_2}^2}{0.8}$$

Cross multiply and make T_2 the subject of the formula

$${T_2}^2 = 8$$

$$T_2 = 2\sqrt{2}s$$

D is the correct answer

WORK, ENERGY AND POWER

Question 1

A bead traveling on a straight wire is brought to rest at 0.2m by friction. If the mass of the bead is 0.01kg and the coefficient of friction between the bead and the wire is 0.1, determine the workdone by the friction. {2003}

A. 2×10^{-4}J B. 2×10^{-3}J C. 2×10^{1}J D. 2×10^{2}J

[g = 10 ms^{-2}.]

Solution

$$f = \mu R$$
$$f = frictional\ force$$

R is the normal reaction

$$f = 0.1 \times 0.01 \times 10$$
$$f = 0.01N$$
$$workdone\ by\ friction = f \times d$$

$$workdone\ by\ friction = 0.01 \times 0.2 = 2 \times 10^{-3}J$$

B is the correct answer

Question2

A body of mass 4kg is acted on by a constant force of 12N for 3 seconds. The kinetic energy gained by the body at the end of the time is {2004}

A. 162J B. 144J C. 72J D. 81J

Solution

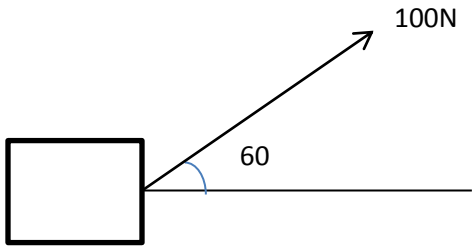
$$f = ma$$
$$12 = 4a$$
$$a = \frac{12}{4}$$
$$a = 3ms^{-2}$$

$$s = \frac{1}{2}at^2$$
$$s = \frac{1}{2} \times 3 \times 3^2 = 13.5m$$

Kinetic energy gained = force x distance= 12 * 13.5 = 162J

A is the correct answer

Question 3



In the figure above, the work done by the force of 100N inclined at an angle of 60^{o} to the object dragged horizontally to a distance of 8m is {2005}

A. 100J B. 400J C. 600J D. 800J

Solution

$$workdone = mgsin\theta \times d$$
$$workdone = 100cos60 \times 8$$
$$workdone = 100 \times 0.5 \times 8 = 400J$$

B is the correct option

Question 4

A boy drags a bag of rice along a smooth horizontal floor with a force of 2N applied at an angle of 60^{o} to the floor. The work done after a distance of 3m is

A. 6J B. 5J C. 4J D 3J

Solution

$$workdone = mgsin\theta \times d$$
$$workdone = 2cos60 \times 3$$
$$workdone = 2 \times 0.5 \times 3 = 3J$$

D is the correct option

Question 5

If a cage containing a truck of coal weighing 750kg is raised to a height of 90m in 1 minute, what is the total power expended?{2009}

A. 11.50 kW B. 12.60 kW C. 11.25 kW D. 12.10 kw

[g · 10ms^{-2}]

Solution

$$power = force \times velocity$$
$$power = 750 \times 10 \times \frac{90}{60}$$
$$power = 11250W = 11.25KW$$

C is the correct answer

Question 6

A bob of weight 0.1N hangs from a massless string of length 50cm. A variable horizontal force which increases from zero is applied to pull the bob until the string makes an angle of 60^{0} with the vertical. The work done is {2010}

A. 0.250 J B. 0.025J C. 0.050 J D. 0.500 J

Solution

The vertical distance = $0.5cos60 = 0.25m$
Workdone = $f \times d = 0.1 \times 0.25 = 0.025J$
B is the correct answer

Question 7
A carpenter on top of a roof 20.m high dropped a hammer of mass 1.5kg and it fell freely to the ground. The kinetic energy of the hammer just before hitting the ground is {2011}
A. 450 J B. 600 J C. 150 J D. 300 J
[g = 10ms^{-2}]
Solution
K.E = P.E
Kinetic energy = mgh = 1.5*20*10 = 300J
D is the correct option

Question 8
An object is moving with a velocity of 5ms^{-1}. At what height must a similar body be situated to have a potential energy equal in value with the kinetic energy of the moving body? {2013}
A. 1.0m B. 25.0m C. 20.0m D. 1.3m

Solution

$$mgh = \frac{1}{2}mv^2$$
$$h = \frac{1}{2g}v^2$$
$$h = \frac{1}{2 \times 10} \times 5^2$$
$$h = 1.25 = 1.3m$$

D is the correct option

Question 9
If a pump is capable of lifting 5000 kg of water through a vertical height of 60 m in 15 min, the power of the pump is {2013}
A. 3.3 x 10^2 Js^{-1} B. 2.5 x 10^5 Js^{-1} C. 2.5 x 10^4 Js^{-1} D. 3.3 x 10^3 Js^{-1}
Solution
Power= energy expended per unit time

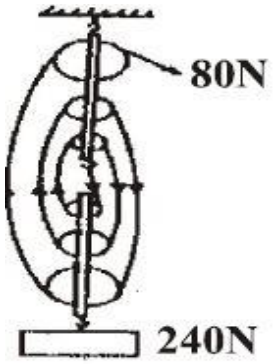
$$power = \frac{f \times h}{t} = \frac{mgh}{t}$$
$$power = \frac{5000 \times 10 \times 60}{60 \times 15} = 3333.3Js^{-1} = 3.3 \times 10^3 Js^{-1}$$

MACHINE

Question 1

The diagram below is a block-and-tackle pulley system in which an effort of 80N is used to lift a load of 240N. The efficiency of the machine is {2001}

A. 40% B. 33% C. 60% D. 50%.



Solution

Velocity ratio = number of pulleys = 6

$$M.A = \frac{load}{effort} = \frac{240}{80} = 3$$

$$efficiency = \frac{M.A}{V.R} \times 100 = \frac{3}{6} \times 100 = 50\%$$

D is the correct answer

The earth is four times the size of the moon and the acceleration due to gravity on the earth is 80 times that on the moon. The ratio of the mass of the moon to that of the earth is(gravitational force 2004)

A. 1 : 320 B. 1 : 1280 C. 1 : 80 D. 1 : 4

Solution

size of earth = 4 x size of moon

G of erath = 80 x g of moon

A bead traveling on a straight wire is brought to rest at 0.2m by friction. If the mass of the bead is 0.01kg and the coefficient of friction between the bead and the wire is 0.1, determine the workdone by the friction.

A. 2×10^{-4}J B. 2×10^{-3}J C. 2×10^{1}J D. 2×10^{2}J

[g = 10 ms^{-1}.]