

Laws of Motion — NEET Physics PYQ (2005-2021)

Class 11 Physics · 30 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2021

1. A ball of mass 0.15 kg is dropped from a height 10 m, strikes the ground and rebounds to the same height. The magnitude of impulse imparted to the ball is ($g = 10 \text{ m/s}^2$) nearly :

- (A) 0 kg m/s
- (B) 4.2 kg m/s
- (C) 2.1 kg m/s
- (D) 1.4 kg m/s

NEET 2020 · Q160

2. Two bodies of mass 4 kg and 6 kg are tied to the ends of a massless string. The string passes over a pulley which is frictionless (see figure). The acceleration of the system in terms of acceleration due to gravity (g) is :

- (A) g
- (B) $g/2$
- (C) $g/5$
- (D) $g/10$

NEET 2019 · Q2

3. A mass m is attached to a thin wire and whirled in a vertical circle. The wire is most likely to break when:

- (A) the mass is at the highest point
- (B) the wire is horizontal
- (C) the mass is at the lowest point
- (D) inclined at an angle of 60° from vertical

NEET 2019 · Q30

4. When an object is shot from the bottom of a long smooth inclined plane kept at an angle 60° with the horizontal, it can travel a distance x_1 along the plane. But when the inclination is decreased to 30° and the same object is shot with the same velocity, it can travel x_2 distance. Then $x_1 : x_2$ will be:

- (A) $1 : \sqrt{2}$
- (B) $\sqrt{2} : 1$
- (C) $1 : \sqrt{3}$
- (D) $1 : 2\sqrt{3}$

NEET 2019 · Q35

5. A block of mass 10 kg is in contact against the inner wall of a hollow cylindrical drum of radius 1 m. The coefficient of friction between the block and the inner wall of the cylinder is 0.1. The minimum angular velocity needed for the cylinder to keep the block stationary when the cylinder is vertical and rotating about its axis, will be: ($g = 10 \text{ m/s}^2$)

- (A) $\sqrt{10} \text{ rad/s}$
- (B) $10/(2\pi) \text{ rad/s}$
- (C) 10 rad/s
- (D) $10\pi \text{ rad/s}$

NEET 2018 · Q33

6. Which one of the following statements is incorrect?

- (A) Frictional force opposes the relative motion.
- (B) Limiting value of static friction is directly proportional to normal reaction.
- (C) Rolling friction is smaller than sliding friction.
- (D) Coefficient of sliding friction has dimensions of length.

7. A body initially at rest, breaks up into two pieces of masses $2M$ and $3M$ respectively, together having a total kinetic energy E . The piece of mass $2M$, after breaking up, has a kinetic energy:

- (A) $E/2$
- (B) $E/5$
- (C) $3E/5$
- (D) $2E/5$

8. A cyclist on a level road takes a sharp circular turn of radius 3 m ($g = 10\text{ m s}^{-2}$). If the coefficient of static friction between the cycle tyres and the road is 0.2 , at which of the following speeds will the cyclist not skid while taking the turn?

- (A) 7.2 km h^{-1}
- (B) 9 km h^{-1}
- (C) 10.8 km h^{-1}
- (D) 14.4 km h^{-1}

9. A car is negotiating a curved road of radius R . The road is banked at an angle θ . The coefficient of friction between the tyres of the car and the road is μ_s . The maximum safe velocity on this road is:

- (A) $\sqrt{(gR^2 (\mu_s + \tan\theta)/(1 - \mu_s \tan\theta))}$
- (B) $\sqrt{(gR (\mu_s + \tan\theta)/(1 - \mu_s \tan\theta))}$
- (C) $\sqrt{((g/R) (\mu_s + \tan\theta)/(1 - \mu_s \tan\theta))}$
- (D) $\sqrt{((g/R^2) (\mu_s + \tan\theta)/(1 - \mu_s \tan\theta))}$

10. A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the table is μ_k . When the block A is sliding on the table, the tension in the string is:

- (A) $m_1 m_2 (1 - \mu_k)g / (m_1 + m_2)$
- (B) $(m_2 + \mu_k m_1)g / (m_1 + m_2)$
- (C) $(m_2 - \mu_k m_1)g / (m_1 + m_2)$
- (D) $m_1 m_2 (1 + \mu_k)g / (m_1 + m_2)$

11. A system consists of three masses m_1 , m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (the coefficient of friction = μ). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is: (Assume $m_1 = m_2 = m_3 = m$)

- (A) $2g\mu/3$
- (B) $g(1 - 2\mu)/3$
- (C) $g(1 - 2\mu)/2$
- (D) $g(1 - g\mu)/9$

12. A balloon with mass ' m ' is descending down with an acceleration ' a ' (where $a < g$). How much mass should be removed from it so that it starts moving up with an acceleration ' a '?

- (A) $2ma/(g - a)$
- (B) $ma/(g + a)$
- (C) $ma/(g - a)$
- (D) $2ma/(g + a)$

NEET 2013

13. Three blocks with masses m , $2m$ and $3m$ are connected by strings (m at the top, $2m$ below it and $3m$ at the bottom). After an upward force F is applied on block m , the masses move upward at constant speed v . What is the net force on the block of mass $2m$? (g is the acceleration due to gravity)

- (A) zero
- (B) $2mg$
- (C) $3mg$
- (D) $6mg$

NEET 2013

14. The upper half of an inclined plane of inclination θ is perfectly smooth while the lower half is rough. A block starting from rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by

- (A) $\mu = 1/\tan \theta$
- (B) $\mu = 2/\tan \theta$
- (C) $\mu = 2 \tan \theta$
- (D) $\mu = \tan \theta$

NEET 2013

15. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1 kg moves with a speed of 12 m s^{-1} and the second part of mass 2 kg moves with 8 m s^{-1} speed. If the third part flies off with 4 m s^{-1} speed, then its mass is

- (A) 3 kg
- (B) 5 kg
- (C) 7 kg
- (D) 17 kg

AIPMT 2012 Mains

16. A car of mass m is moving on a level circular track of radius R . If μ_s represents the static friction between the road and tyres of the car, the maximum speed of the car in circular motion is given by

- (A) $\sqrt{(\mu_s m R g)}$
- (B) $\sqrt{(R g / \mu_s)}$
- (C) $\sqrt{(m R g / \mu_s)}$
- (D) $\sqrt{(\mu_s R g)}$

AIPMT 2012 Prelims

17. A car of mass 1000 kg negotiates a banked curve of radius 90 m on a frictionless road. If the banking angle is 45° , the speed of the car is

- (A) 10 m s^{-1}
- (B) 20 m s^{-1}
- (C) 30 m s^{-1}
- (D) 5 m s^{-1}

AIPMT 2011 Mains

18. A conveyor belt is moving at a constant speed of 2 m/s . A box is gently dropped on it. The coefficient of friction between them is $\mu = 0.5$. The distance that the box will move relative to belt before coming to rest on it, taking $g = 10 \text{ m s}^{-2}$, is

- (A) Zero
- (B) 0.4 m
- (C) 1.2 m
- (D) 0.6 m

AIPMT 2011 Prelims

19. A person of mass 60 kg is inside a lift of mass 940 kg and presses the button on the control panel. The lift starts moving upwards with an acceleration 1.0 m/s^2 . If $g = 10 \text{ m/s}^2$, the tension in the supporting cable is

- (A) 1200 N
- (B) 8600 N
- (C) 9680 N
- (D) 11000 N

AIPMT 2011 Prelims

20. A body of mass M hits normally a rigid wall with velocity V and bounces back with the same velocity. The impulse experienced by the body is

- (A) Zero
- (B) MV
- (C) $1.5 MV$
- (D) $2 MV$

AIPMT 2010 Prelims · Q9

21. A gramophone record is revolving with an angular velocity ω . A coin is placed at a distance r from the centre of the record. The static coefficient of friction is μ . The coin will revolve with the record if

- (A) $r \geq \mu g / \omega^2$
- (B) $r = \mu g \omega^2$
- (C) $r < \omega^2 / (\mu g)$
- (D) $r \leq \mu g / \omega^2$

AIPMT 2009 Prelims · Q7

22. A body, under the action of a force $\mathbf{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$, acquires an acceleration of 1 m/s^2 . The mass of this body must be:

- (A) 10 kg
- (B) 20 kg
- (C) $10\sqrt{2}$ kg
- (D) $2\sqrt{10}$ kg

AIPMT 2009 Prelims · Q14

23. The mass of a lift is 2000 kg. When the tension in the supporting cable is 28000 N, then its acceleration is:

- (A) 4 m/s^2 upwards
- (B) 4 m/s^2 downwards
- (C) 14 m/s^2 upwards
- (D) 30 m/s^2 downwards

AIPMT 2009 Prelims · Q39

24. An explosion blows a rock into three parts. Two parts go off at right angles to each other. These two are, 1 kg first part moving with a velocity of 12 m/s and 2 kg second part moving with a velocity of 8 m/s . If the third part flies off with a velocity of 4 m/s , its mass would be:

- (A) 7 kg
- (B) 17 kg
- (C) 3 kg
- (D) 5 kg

AIPMT 2008 Prelims · Q6

25. A particle of mass m is projected with velocity v making an angle of 45° with the horizontal. When the particle lands on the level ground the magnitude of the change in its momentum will be

- (A) zero
- (B) $2mv$
- (C) $mv/\sqrt{2}$
- (D) $mv\sqrt{2}$

AIPMT 2008 Prelims · Q7

26. Sand is being dropped on a conveyor belt at the rate of M kg/s. The force necessary to keep the belt moving with a constant velocity of v m/s will be

- (A) Zero
- (B) Mv newton
- (C) $2 Mv$ newton
- (D) $Mv/2$ newton

AIPMT 2008 Prelims · Q10

27. A shell of mass 200 g is ejected from a gun of mass 4 kg by an explosion that generates 1.05 kJ of energy. The initial velocity of the shell is

- (A) 120 m s^{-1}
- (B) 100 m s^{-1}
- (C) 80 m s^{-1}
- (D) 40 m s^{-1}

AIPMT 2007 Prelims · Q17

28. A block B is pushed momentarily along a horizontal surface with an initial velocity V . If μ is the coefficient of sliding friction between B and the surface, block B will come to rest after a time

- (A) $g\mu/V$
- (B) g/V
- (C) V/g
- (D) $V/(g\mu)$

AIPMT 2006 Prelims · Q29

29. A 0.5 kg ball moving with a speed of 12 m/s strikes a hard wall at an angle of 30° with the wall. It is reflected with the same speed and at the same angle. If the ball is in contact with the wall for 0.25 s, the average force acting on the wall is :

- (A) 8 N
- (B) 24 N
- (C) 16 N
- (D) 96 N

AIPMT 2005 Prelims · Q4

30. A bomb of mass 30 kg at rest explodes into two pieces of masses 18 kg and 12 kg. The velocity of 18 kg mass is 6 m s^{-1} . The kinetic energy of the other mass is :

- (A) 243 J
- (B) 486 J
- (C) 564 J
- (D) 388 J

Answer key and explanations

1. Answer: (B) 4.2 kg m/s

Speed just before impact $v = \sqrt{2gh} = \sqrt{200} \approx 14.1 \text{ m/s}$; it rebounds to the same height, so it leaves with 14.1 m/s upward. Impulse = change in momentum = $2mv = 2 \times 0.15 \times 14.1 \approx 4.2 \text{ kg m/s}$. 2.1 kg m/s ignores the reversal of direction.

2. Answer: (C) $g/5$

For two masses hanging over a frictionless pulley, $a = (m_2 - m_1)g/(m_1 + m_2) = (6 - 4)g/10 = g/5$. Using only the heavier mass in the denominator, or forgetting the difference of weights, gives the other values.

3. Answer: (C) the mass is at the lowest point

At the lowest point the tension must supply the centripetal force and also balance the full weight, $T = mg + mv^2/r$, and the speed is also maximum there, so tension is greatest. At the highest point gravity helps provide the centripetal force, so tension is least.

4. Answer: (C) $1 : \sqrt{3}$

On a smooth incline the deceleration is $g \sin \theta$, so $x = u^2/(2g \sin \theta)$. $x_1/x_2 = \sin 30^\circ/\sin 60^\circ = (1/2)/(\sqrt{3}/2) = 1 : \sqrt{3}$. A steeper incline decelerates the object more, so x_1 must be the smaller distance.

5. Answer: (C) 10 rad/s

The normal force supplies the centripetal force, $N = m\omega^2 r$, and friction must balance weight: $\mu m\omega^2 r \geq mg$. $\omega^2 = g/(\mu r) = 10/(0.1 \times 1) = 100$, so $\omega = 10 \text{ rad/s}$. $\sqrt{10} \text{ rad/s}$ forgets to divide by μ .

6. Answer: (D) Coefficient of sliding friction has dimensions of length.

The coefficient of friction is a ratio of two forces (friction/normal reaction), so it is dimensionless; the statement that it has dimensions of length is wrong. The other statements are standard properties of friction.

7. Answer: (C) $3E/5$

Momentum conservation gives equal and opposite momenta p , and $KE = p^2/2m$, so kinetic energy is inversely proportional to mass. $KE(2M) : KE(3M) = 3 : 2$, so the $2M$ piece gets $3E/5$. $2E/5$ is what you get by wrongly sharing the energy in proportion to mass.

8. Answer: (A) 7.2 km h^{-1}

Friction must supply the centripetal force, so $v_{\text{max}} = \sqrt{\mu g r} = \sqrt{0.2 \times 10 \times 3} = \sqrt{6} \approx 2.45 \text{ m s}^{-1} \approx 8.8 \text{ km h}^{-1}$. Only 7.2 km h^{-1} (2 m s^{-1}) is below this limit; 9 km h^{-1} (2.5 m s^{-1}) is just above it, so the cyclist would skid.

9. Answer: (B) $\sqrt{gR(\mu_s + \tan \theta)/(1 - \mu_s \tan \theta)}$

With friction acting down the incline at the maximum speed, resolving forces gives $v^2/(Rg) = (\sin \theta + \mu_s \cos \theta)/(\cos \theta - \mu_s \sin \theta) = (\mu_s + \tan \theta)/(1 - \mu_s \tan \theta)$. So $v_{\text{max}} = \sqrt{gR(\mu_s + \tan \theta)/(1 - \mu_s \tan \theta)}$; only this form has units of velocity.

10. Answer: (D) $m_1 m_2 (1 + \mu_k) g / (m_1 + m_2)$

$a = (m_2 - \mu_k m_1)g/(m_1 + m_2)$. For block A: $T - \mu_k m_1 g = m_1 a$, so $T = m_1[(m_2 - \mu_k m_1)g/(m_1 + m_2) + \mu_k g] = m_1 m_2 (1 + \mu_k) g / (m_1 + m_2)$. Friction increases the tension compared with the frictionless value.

11. Answer: (B) $g(1 - 2\mu)/3$

The driving force is $m_1 g = mg$ and friction on the two table masses is $2\mu mg$, while all three masses ($3m$) accelerate together. $a = (mg - 2\mu mg)/(3m) = g(1 - 2\mu)/3$.

12. Answer: (D) $2ma/(g + a)$

Descending: $mg - U = ma$, so the upthrust $U = m(g - a)$. Rising with mass m' : $U - m'g = m'a$, so $m' = m(g - a)/(g + a)$. Mass removed = $m - m' = 2ma/(g + a)$.

13. Answer: (A) zero

All three blocks move at constant velocity, so their acceleration is zero and by Newton's second law the net force on each block, including $2m$, is zero. $2mg$ is only the weight of that block, which is balanced by the string tensions.

14. Answer: (C) $\mu = 2 \tan \theta$

Let the plane length be L . Gain in KE from gravity over the full length, $mg \sin \theta \cdot L$, must equal the friction work on the rough lower half, $\mu mg \cos \theta \cdot (L/2)$. This gives $\mu = 2 \tan \theta$. $\mu = \tan \theta$ would only stop the acceleration on the rough part, not bring the block to rest.

15. Answer: (B) 5 kg

Initial momentum is zero. The first two momenta are $1 \times 12 = 12$ and $2 \times 8 = 16 \text{ kg m s}^{-1}$ at right angles, giving a resultant $\sqrt{12^2 + 16^2} = 20 \text{ kg m s}^{-1}$. The third part must carry 20 kg m s^{-1} in the opposite direction, so $m = 20/4 = 5 \text{ kg}$.

16. Answer: (D) $\sqrt{(\mu_s Rg)}$

Static friction supplies the centripetal force: $mv^2/R \leq \mu_s \cdot mg$, so $v_{\text{max}} = \sqrt{(\mu_s Rg)}$. The mass cancels, so expressions containing m cannot be right.

17. Answer: (C) 30 m s^{-1}

On a frictionless banked road, $\tan \theta = v^2/(rg)$. With $\theta = 45^\circ$, $v = \sqrt{rg} = \sqrt{90 \times 10} = 30 \text{ m s}^{-1}$ ($g = 10 \text{ m s}^{-2}$). The mass of the car does not enter the result.

18. Answer: (B) 0.4 m

Relative to the belt the box starts at 2 m/s and friction gives it a relative deceleration $\mu g = 5 \text{ m/s}^2$. Relative distance $= u^2/2a = 4/10 = 0.4 \text{ m}$. The answer zero ignores that the box slips until it reaches the belt speed.

19. Answer: (D) 11000 N

The cable accelerates the lift and the person together (total mass 1000 kg) upward at 1 m/s^2 , so $T - (M + m)g = (M + m)a$, giving $T = 1000 \times (10 + 1) = 11000 \text{ N}$. Using only the lift's mass or ignoring the acceleration gives the smaller values.

20. Answer: (D) 2 MV

Impulse equals change in momentum: taking the initial direction as positive, $\Delta p = (-MV) - (MV) = -2MV$, so its magnitude is $2MV$. Zero would only be the change in speed, not in momentum.

21. Answer: (D) $r \leq \mu g/\omega^2$

Static friction supplies the centripetal force: $mr\omega^2 \leq \mu mg$, so the coin stays on if $r \leq \mu g/\omega^2$. The reversed inequality $r \geq \mu g/\omega^2$ describes when the coin slips off.

22. Answer: (C) $10\sqrt{2} \text{ kg}$

$|F| = \sqrt{6^2 + 8^2 + 10^2} = \sqrt{200} = 10\sqrt{2} \text{ N}$. With $a = 1 \text{ m/s}^2$, $m = F/a = 10\sqrt{2} \text{ kg}$. Simply adding the components or taking $2\sqrt{10}$ is a mistake in the magnitude.

23. Answer: (A) 4 m s^{-2} upwards

$T - mg = ma$ gives $28000 - 2000 \times 10 = 2000a$, so $a = 4 \text{ m s}^{-2}$ upwards. The tension exceeds the weight, so the acceleration must be upward; 14 m s^{-2} ignores gravity.

24. Answer: (D) 5 kg

Momenta of the two pieces are $1 \times 12 = 12$ and $2 \times 8 = 16 \text{ kg m s}^{-1}$ at right angles, with resultant $\sqrt{12^2 + 16^2} = 20 \text{ kg m s}^{-1}$. The third piece must carry an equal and opposite 20 kg m s^{-1} , so $m = 20/4 = 5 \text{ kg}$.

25. Answer: (D) $mv\sqrt{2}$

The horizontal momentum $mv \cos 45^\circ$ is unchanged, while the vertical component $mv \sin 45^\circ$ reverses. The change is $2mv \sin 45^\circ = \sqrt{2} mv$. The answer is not zero, because momentum is a vector and its direction has changed even though the speed is the same.

26. Answer: (B) Mv newton

Each second a mass M of sand must be brought from zero to speed v , so $F = v(dm/dt) = Mv$ newton. The force is not zero: even at constant belt speed, the momentum of the system keeps increasing as sand is added.

27. Answer: (B) 100 m s^{-1}

Momentum conservation: $0.2v = 4V$, so the gun recoils with $V = v/20$. Energy: $(1/2) \times 0.2 \times v^2 + (1/2) \times 4 \times (v/20)^2 = 0.1v^2 + 0.005v^2 = 0.105v^2 = 1050$, so $v^2 = 10^4$ and $v = 100 \text{ m s}^{-1}$. Ignoring the gun's recoil energy would give about 102 m s^{-1} , so the recoil share must be included.

28. Answer: (D) $V/(g\mu)$

Friction gives a deceleration μg , so the block stops when $V - \mu gt = 0$, i.e. $t = V/(\mu g)$. V/g ignores the friction coefficient.

29. Answer: (B) 24 N

The ball meets the wall at 30° to the wall, so its velocity component normal to the wall is $12 \sin 30^\circ = 6 \text{ m/s}$; this component reverses while the parallel component is unchanged. $\Delta p = 2 \times 0.5 \times 6 = 6 \text{ kg m/s}$ and $F = 6/0.25 = 24 \text{ N}$. Using $\cos 30^\circ$ (treating the angle as measured from the normal) gives about 41.6 N , which is not offered.

30. Answer: (B) 486 J

Momentum conservation from rest: $18 \times 6 = 12 \times v$, so $v = 9 \text{ m/s}$. $KE = \frac{1}{2} \times 12 \times 81 = 486 \text{ J}$. 243 J is half the correct value.

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