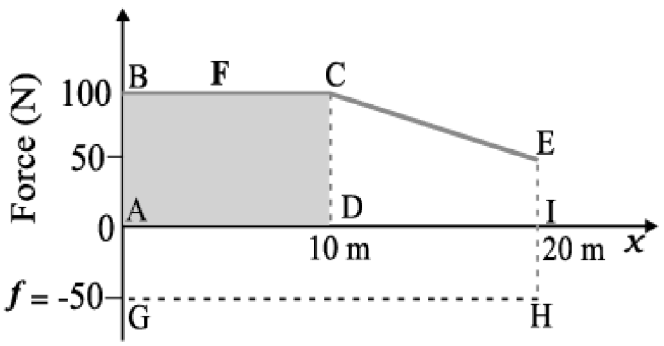
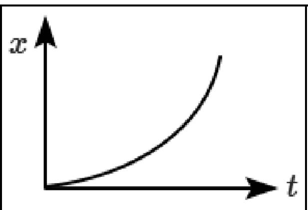
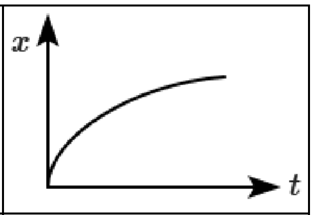
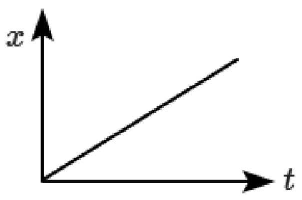
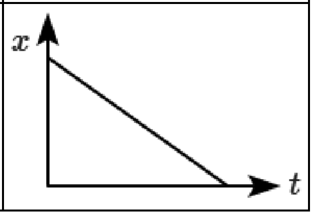
Section A

1 A woman pushes a trunk on a railway platform which has a rough surface. She applies a force of 100 N over a distance of 10 m. Thereafter, she gets progressively tired and her applied force reduces linearly with distance to 50 N. The total distance through which the trunk has been moved is 20 m. The plot of force applied by the woman and the frictional force, which is 50 N versus displacement is given below. Work done by the two forces over 20 m are:



1. 1750 J and −1000 J
2. 1750 J and 1000 J
3. −1750 J and 1000 J
4. −1750 J and −1000 J

2 The position-time $(x-t)$ graph for positive acceleration is:

1.		2.	
3.		4.	

3 A bullet of mass m fired at 30° to the horizontal leaves the barrel of the gun with a velocity v. The bullet hits a soft target at a height h above the ground while it is moving downward and emerge out with half the kinetic energy it had before hitting the target. Consider the following statements.

a.	the velocity of the bullet will be reduced to half its initial value.
b.	the velocity of the bullet will be more than half of its earlier velocity.
c.	the bullet will continue to move along the same parabolic path.
d.	the bullet will move in a different parabolic path.
e.	the bullet will fall vertically downward after hitting the target.
f.	the internal energy of the particles of the target will increase.

Which of the above-given statement(s) is/are correct in respect of the bullet after it emerges out of the target?

1.	(a, c, f)
2.	(a, d, f)
3.	(b, d, f)
4.	(a, b, c)

4 The energy that will be ideally radiated by a 100 kW transmitter in 1 hour is:

1. 1×10^5 J
2. 36×10^7 J
3. 36×10^4 J
4. 36×10^5 J

5 A man pushes a 4 kg block with a force of 12 N and finds that it starts with an acceleration of 2 m/s^2. After some time he finds that to keep the block in motion with uniform velocity of 4 m/s, he needs only a constant force of 2 N. The coefficient of static friction is: (Take $g = 10$ m/s^2)

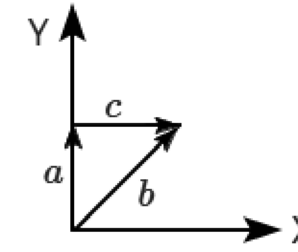
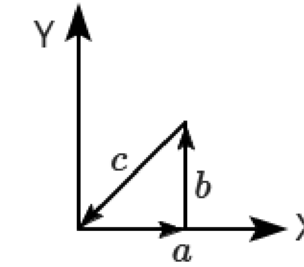
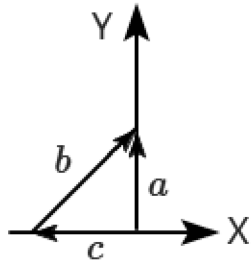
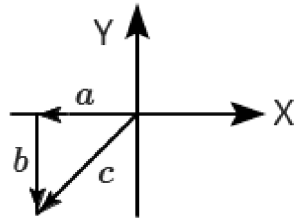
1. 0.5
2. 0.2
3. 0.1
4. 0.05

6 Given below are two statements:

Assertion (A):	Centripetal force does no work.
Reason (R):	Force and displacement are perpendicular to each other.

1.	Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.
2.	Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**.
3.	**(A)** is true but **(R)** is false.
4.	Both **(A)** and **(R)** are false.

7 Given below in Column-I are the relations between vectors a, b, and c and in Column-II are the orientations of a, b, and c in the XY-plane. Match the relation in Column-I to the correct orientations in Column-II.

	Column-I		Column-II
a	$a+b=c$	(i)	
b	$a-c=b$	(ii)	
c	$b-a=c$	(iii)	
d	$a+b+c=0$	(iv)	

1.	a(ii), b (iv), c(iii), d(i)
2.	a(i), b (iii), c(iv), d(ii)
3.	a(iv), b (iii), c(i), d(ii)
4.	a(iii), b (iv), c(i), d(ii)

8 During an inelastic collision between two bodies, which of the following quantities always remain conserved?
1. total kinetic energy
2. total mechanical energy
3. total linear momentum
4. speed of each body

9 Given below are two statements:

Assertion (A):	In a non-uniform circular motion, there are two types of accelerations i.e. centripetal and tangential.
Reason (R):	Tangential acceleration is responsible to change the speed of the particle moving in a circular motion.

1.	Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.
2.	Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**.
3.	**(A)** is true but **(R)** is false.
4.	Both **(A)** and **(R)** are false.

10 Position x of a particle moving on a straight line as a function of time t is $x=(2t^2-12t+5)$ m. The particle will come to rest at time t equal to:
1. 2 s
2. 1 s
3. 4 s
4. 3 s

11 The speed of a boat is 5 km/hr in still water. It crosses a river of width 1 km along the shortest possible path in 15 minutes. The velocity of river water is:
1. 3 km/hr
2. 4 km/hr
3. 5 km/hr
4. 2 km/hr

12 A cricket ball is thrown at a speed of 28 m/s in a direction 30° above the horizontal. The time taken by the ball to return to the same level is:
1. 2.5 s
2. 2.9 s
3. 3.5 s
4. 3 s

13 The length of an elastic metallic wire is l_1 when tension in it is T_1. It is l_2 when the tension is T_2. The original length of the wire will be:
1. $\frac{l_1+l_2}{2}$
2. $\frac{T_2 l_1+T_1 l_2}{T_1+T_2}$
3. $\frac{T_2 l_1-T_1 l_2}{T_2-T_1}$
4. $\frac{T_1 l_1-T_2 l_2}{T_2-T_1}$

14 Which of the following is the most precise device for measuring length?

1.	a vernier callipers with 20 divisions on the sliding scale.
2.	a screw gauge of pitch 1 mm and 100 divisions on the circular scale.
3.	an optical instrument that can measure the length within a wavelength of light.
4.	both (1) and (2).

15 A body with a mass of 5 kg is acted upon by a force $\vec{F}=\left(-3\hat{i}+4\hat{j}\right)$ N. If its initial velocity at $t=0$ is $\vec{v}=\left(6\hat{i}-12\hat{j}\right)$ m/s, the time at which it will just have a velocity along the Y-axis is:
1. never
2. 10 s
3. 2 s
4. 15 s

16 The relative error in Z, if $Z=\frac{A^4B^{1/3}}{CD^{3/2}}$ is:
1. $\frac{\Delta A}{A}+\frac{\Delta B}{B}+\frac{\Delta C}{C}+\frac{\Delta D}{D}$
2. $4\frac{\Delta A}{A}+\frac{1}{3}\frac{\Delta B}{B}-\frac{\Delta C}{C}-\frac{3}{2}\frac{\Delta D}{D}$
3. $4\frac{\Delta A}{A}+\frac{1}{3}\frac{\Delta B}{B}+\frac{\Delta C}{C}+\frac{2}{3}\frac{\Delta D}{D}$
4. $4\frac{\Delta A}{A}+\frac{1}{3}\frac{\Delta B}{B}+\frac{\Delta C}{C}+\frac{3}{2}\frac{\Delta D}{D}$

17 A vector $\vec{a}$ is turned without a change in its length through a small angle $d\theta$. The value of $|\Delta\vec{a}|$ and Δa are respectively:
1. $0,\ ad\theta$
2. $ad\theta$, 0
3. 0, 0
4. none of these

18 Given below are two statements:

Assertion (A):	The speed of a whirlwind in a tornado is alarmingly high.
Reason (R):	If no external torque acts on a body, its angular velocity remains conserved.

1.	Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.
2.	Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**.
3.	**(A)** is true but **(R)** is false.
4.	Both **(A)** and **(R)** are false.

19 The centre of a wheel rolling on a plane surface moves with a speed v_0. A particle on the rim of the wheel at the same level as the centre will be moving at speed:

1. zero
2. v_0
3. $\sqrt{2}v_0$
4. $2v_0$

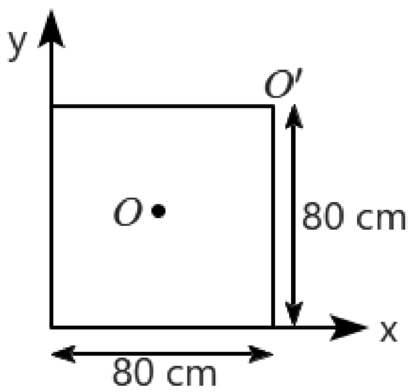
20 Given, $F = 2x^2 - 3x - 2$. Choose correct option:

1.	$x = -1/2$ is position of stable equilibrium
2.	$x = 2$ is position of stable equilibrium
3.	$x = -1/2$ is position of unstable equilibrium
4.	$x = 2$ is position of neutral equilibrium

21 A couple produces:

1.	purely linear motion
2.	purely rotational motion
3.	linear and rotational motion
4.	no motion

22 For a uniform rectangular sheet shown in the figure, if I_O and $I_{O'}$ be moments of inertia about the axes perpendicular to the sheet and passing through O (the centre of mass) and O' (corner point), then:

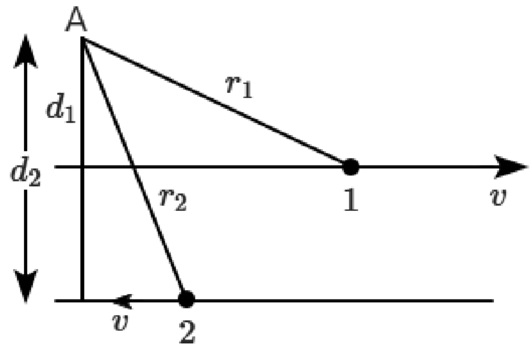


1. $I_{O'} = I_O$
2. $I_{O'} < I_O$
3. $I_{O'} > I_O$
4. can't say

23 All the particles of a body are situated at a distance R from the origin. The distance of the centre of mass of the body from the origin is:

1. $= R$
2. $\leq R$
3. $> R$
4. $\geq R$

24 The figure below shows two identical particles 1 and 2, each of mass m, moving in opposite directions with the same speed v along parallel lines. At a particular instant, r_1 and r_2 are their respective position vectors drawn from point A, which is in the plane of the parallel lines.



Consider the following statements.

a.	angular momentum l_1 of particle 1 about A is $l_1 = mv(d_1)$ ⊙
b.	angular momentum l_1 of particle 2 about A is $l_1 = mv(r_2)$ ⊙
c.	total angular momentum of the system about A is $l = mv(r_1 + r_2)$ ⊙
d.	total angular momentum of the system about A is $l = mv(d_2 - d_1)$ ⊗

Choose the correct option:

1.	(a, c)
2.	(a, d)
3.	(b, d)
4.	(b, c)

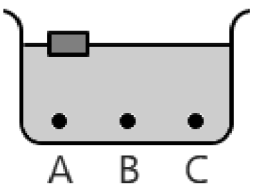
25 A solid cylinder of mass 20 kg rotates about its axis with angular speed 100 rad s^{-1}. The radius of the cylinder is 0.25 m. The kinetic energy associated with the rotation of the cylinder is:

1. 3000 J
2. 3125 J
3. 2528 J
4. 2100 J

26 The average thermal energy for a mono-atomic gas is:
(k_B is Boltzmann constant and T absolute temperature)
1. $\frac{3}{2}k_BT$
2. $\frac{5}{2}k_BT$
3. $\frac{7}{2}k_BT$
4. $\frac{1}{2}k_BT$

27 The amount of work to be done to form a soap bubble of radius R is:
($S =$ surface tension of soap bubble)
1. $8\pi R^2 S$
2. $\frac{3}{2}\pi R^2 S$
3. $24\pi R^2 S$
4. $4\pi R^2 S$

28 A wooden object floats in water kept in a beaker. The object is near a side of the beaker (figure). Let P_1, P_2, P_3 be the pressures at the three points A, B and C of the bottom as shown in the figure.

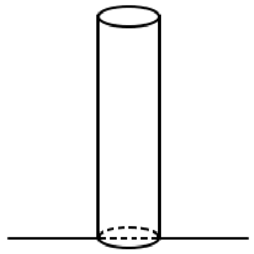


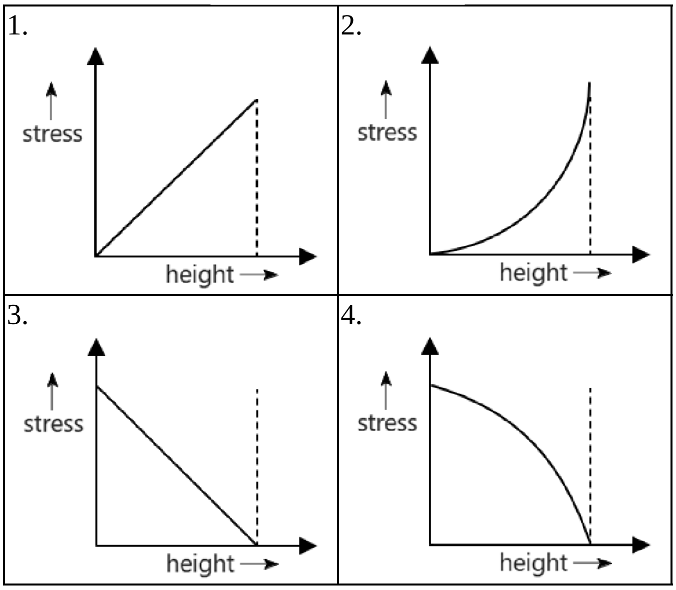
Then:
1. $P_1 = P_2 = P_3$
2. $P_1 < P_2 < P_3$
3. $P_1 = P_2 \neq P_3$
4. $P_2 = P_3 \neq P_1$

29 The first law of thermodynamics is a statement of:
1. conservation of heat
2. conservation of work
3. conservation of momentum
4. conservation of energy.

30 The Young's modulus of the material of the wire of length L and radius r is Y N/m^2. If the length is reduced to $\frac{L}{2}$ and radius $\frac{r}{2}$, the Young's modulus will be:
1. $\frac{Y}{2}$
2. Y
3. $2Y$
4. $4Y$

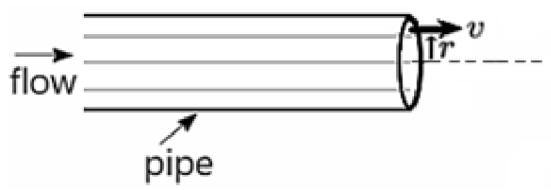
31 A large cylindrical piece of a dense solid elastic metal stands on its end as shown in the figure. The metal is uniform and isotropic. The stress in the material as a function of height is shown correctly by:



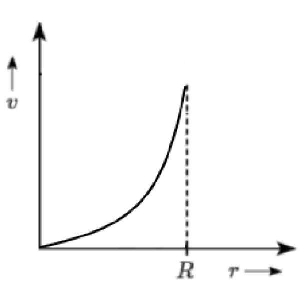
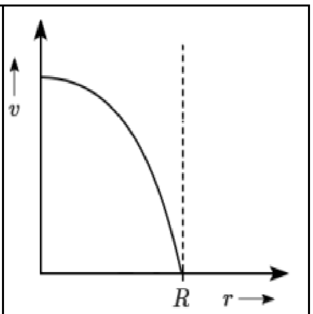
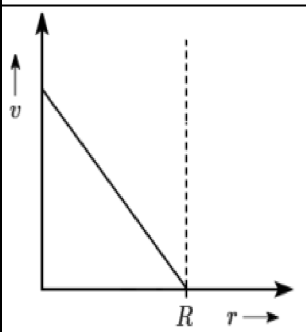
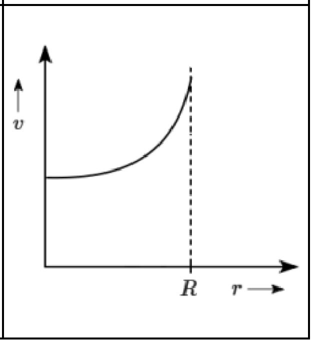


32 The coefficient of performance of a refrigerator is 5. If the temperature inside the freezer is -20°C, the temperature of the surroundings to which it rejects heat is:
1. 31°C
2. 41°C
3. 11°C
4. 21°C

33 A viscous liquid flows slowly through a pipe of cross-sectional radius R. The speed of the particles is a function of the distance from the axis of the pipe.

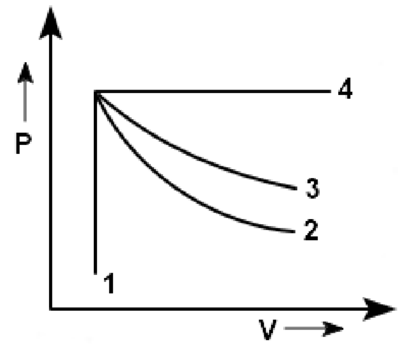


Assume that the flow is smooth. The variation of v vs r is best given by the graph:

1.		2.	
3.		4.	

34 The escape velocity of a particle of mass m varies as:
1. m^2
2. m
3. m^0
4. m^{-1}

35 An ideal gas undergoes four different processes from the same initial state (figure). Four processes are adiabatic, isothermal, isobaric and isochoric. Out of 1, 2, 3 and 4, which one is adiabatic?



1. 4
2. 3
3. 2
4. 1

SECTION B

36 Two cylinders A and B fitted with pistons contain equal amounts of an ideal diatomic gas at 300 K. The piston A is free to move, while that of B is held fixed. The same amount of heat is given to the gas in each cylinder. If the rise in temperature of the gas in A is 30 K, then the rise in temperature of the gas in B is:
1. 30 K
2. 18 K
3. 50 K
4. 42 K

37 The diameter of the water vapour molecule is 2×10^{-10} m and the number of molecules per unit volume at STP is $2.7\times10^{25}\ \mathrm{m}^{-3}$. The mean free path for a water molecule in water vapour at 373 K is:
1. 2.5×10^{-7} m
2. 6×10^{-7} m
3. 3×10^{-7} m
4. 4×10^{-7} m

38 A geostationary satellite is orbiting the earth at a height of $5R$ above the surface of the earth, R being the radius of the earth. The time period of another satellite in hours at a height of $2R$ from the surface of the earth is:
1. 5
2. 10
3. $6\sqrt{2}$
4. $\frac{6}{\sqrt{2}}$

39 In Millikan's oil drop experiment, what is the terminal speed of an uncharged drop of radius 2×10^{-5} m and density 1.2×10^3 kg-m^{-3}?
(Take the viscosity of air at the temperature of the experiment to be 1.8×10^{-5} Pa-s.)
1. 2.7 cm/s
2. 3.9 cm/s
3. 5.8 cm/s
4. 4.6 cm/s

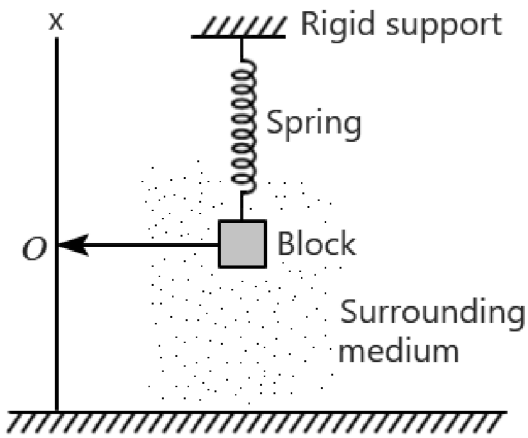
40 A rope of negligible mass is wound around a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N?
(Assume that there is no slipping.)
1. 21 rad/s^2
2. 24 rad/s^2
3. 20 rad/s^2
4. 25 rad/s^2

41 An object kept in a large room having an air temperature of 25°C takes 12 minutes to cool from 80°C to 70°C. The time taken to cool for the same object from 70°C to 60°C would be nearly:
1. 10 min
2. 12 min
3. 20 min
4. 15 min

42 The value of the coefficient of volume expansion of glycerine is 5×10^{-4} K^{-1}. The fractional change in the density of glycerine for a rise of 40°C in its temperature is:
1. 0.015
2. 0.020
3. 0.025
4. 0.010

43 The transverse displacement of a string (clamped at both ends) is given by;
$y(x,t) = 0.06 sin\left(\frac{2\pi}{3}x\right) cos(120\pi t)$
where x and y are in metre and t in second. The length of the string is 1.5 m and its mass is 3×10^{-2} kg. The tension in the string is:
1. 540 N
2. 648 N
3. 200 N
4. 425 N

44 For the damped oscillator shown in the figure, the mass m of the block is 200 g, $k = 90$ N/m and the damping constant b is 40 g/s. The period of oscillation is:



1. 0.03 s
2. 0.3 s
3. 3 s
4. 3.4 s

45 A policeman buzzes a whistle of frequency 420 Hz. A car audio recorder is moving towards the policeman with a speed of 72 km/h record a frequency of ν_1. After crossing it records the frequency of ν_2, then $\nu_1 - \nu_2$ is:
(Velocity of sound is 300 m/s)
1. $\sqrt{2}$ Hz
2. 20 Hz
3. 28 Hz
4. 56 Hz

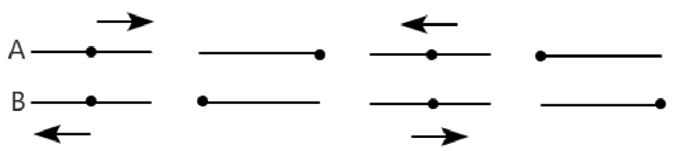
46 A block whose mass is 1 kg is fastened to a spring. The spring has a spring constant of $50 \mathrm{~N} \mathrm{~m}^{-1}$. The block is pulled to a distance $x=10$ cm from its equilibrium position at $x=0$ on a frictionless surface from rest at $t=0$. The kinetic energy of the block when it is 5 cm away from the mean position is:
1. 1.9 J
2. 0.29 J
3. 0.19 J
4. 2.9 J

47 Two plane progressive waves are given by;
$\mathrm{y}_1=\mathrm{A} \sin (\mathrm{at}-\mathrm{bx})$ and $\mathrm{y}_2=\mathrm{A} \cos \left(\mathrm{bx}+\mathrm{at}+\frac{\pi}{6}\right)$, where y_1 and y_2 are the displacement of a medium particle, t is time, a and b are positive constants and other symbols have their usual meaning. Both waves,

1.	have the same phase
2.	are moving in the same direction
3.	have a different wavelength
4.	have the same speed

48 The fundamental frequency of an open organ pipe is 200 Hz. When the half-length of the pipe is immersed in water, the fundamental frequency of the air column in the pipe will be:
1. 100 Hz
2. 200 Hz
3. 400 Hz
4. 800 Hz

49 The figure represents two simple harmonic motions.



The parameter which has different values in the two motions is:
1. amplitude
2. frequency
3. phase
4. maximum velocity

50 If a simple pendulum be suspended in an elevator which is moving upward, its time period is found to decrease by 2%. The acceleration of the elevator is (in magnitude):
1. 2% of g
2. 1% of g
3. 4% of g
4. 102% of g

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