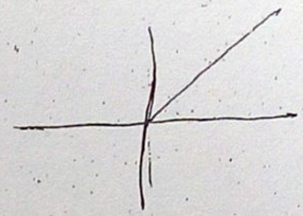
UNIVERSITY OF IBADAN
DEPARTMENT OF PHYSICS
B.Sc. (Honours) Degree Examination, 2002/2003 Session
PHY 114 – Basic Principles of Physics I
1st Semester Examination

Date: 14/10/2003 **Time:** 8:30 – 10:30a.m.

Answer Any Two Questions

Write your name and Matric No. on your question paper.



Where necessary take: g = 9.80m/s^2

1 (a) With the aid of a labelled graph, describe the features exhibited by a typical material under increasing stress.

(b) What do you understand by

(i) Young's modulus (ii) Shear modulus and (iii) Bulk modulus of a material.

(c) Define work and derive its dimensions.

The energy E of a system is given by the equation $E = \frac{P^2}{2M} - 3e^2/(2 \barwedge fd) - bx^{-1}$,

where E has the dimension of work; P is the momentum; e is an electric charge, and x and d both have dimensions of length. Determine the dimensions of b and M.

(d) Two forces D and E are 12N at 40^0 to the positive x-axis and 14N along the negative x-axis respectively. Find (i) ($\underline{E}$ + $\underline{D}$) and (ii) ($\underline{E}$ – $\underline{D}$) in magnitude and direction

2 (a) State and explain Newton's first law of motion.

(b) Show that, in Atwood Machine, the acceleration, $a = \left(\frac{M_2 - m_1}{M_2 + m_1}\right)g$ and the tension, T in the string, $T = \left(\frac{2M_2 m_1}{M_2 + m_1}\right)g$ If M_2 and m_1 are the two un-equal masses ($M_2 > m_1$) and g is the acceleration due to gravity.

(c) State the parallel axes theorem

(d) Calculate the moment of inertia of the wire bent into three semi-circles of radius R each about the point 5R from any of its two ends. (R represents radius of each semi-circle).

3 (a) (i) Define Range as it relates to a projective.

(ii) A basketball is thrown at 45^0 above the horizontal. The hoop is located 4m away horizontally at a height of 0.8m above the point of release. What is the required initial speed for a goal to be scored?

(b) Show that the motion of a mass hanging from a vertical spring (helical spring) is simple harmonic.

(c) A particle executes simple harmonic motion at a frequency 4.2Hz, with an amplitude of 0.09m. The particle is at the origin at time t = o. Calculate (i) the period, (ii) the angular frequency, (iii) the maximum speed and the acceleration at time $t = \frac{1}{24}$ sec.

4 (a) (i) Define (α) the dimension of a physical quantity and (β) the scalar product of two vectors $\underline{A}$ and $\underline{B}$.

(ii) Two passenger trains are passing each other on adjacent tracks. Train 1 is moving North with a speed of 21m/s, and train 2 is traveling South with a speed of 46mls. What is (α) the velocity (magnitude and direction) of train 1 as seen by the passengers in train 2 (β) the velocity (magnitude and direction) of train 2 as seen by the passengers in train 1.

(iii) Show that the total energy in simple harmonic motion is $\frac{1}{2} m\omega^2 A^2$ where m is the mass, ω is the angular frequency and A is the amplitude of vibration.

(b) A cylindrical copper wire and a cylindrical steel wire, each of length 1.5m and diameter 2mm, are joined at one end to form a composite wire 3m long. The wire is loaded until its length becomes 3.003m. Calculate the strains in the copper and steel wires and the applied force to the wire if $Y_{copper} = 1.2 \times 10^{11}$ Nm^{-2} and $Y_{steel} = 2.0 \times 10^{11}$ Nm^{-2}.

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CIRCLE OF PRELIM MUSLIM SCIENCE STUDENTS UI

PHY 114 TEST 45mins

1. A Peugeot 306 Saloon car was driven from Lagos to Ibadan with a displacement vector defined as

   $S = 10.6t^2 i + 14.6t j$ when s is in metres and t is in seconds.

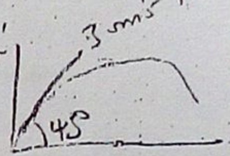
   The mass of the car is 350kg.

   (i) Calculate the distance covered at t = 5mins.

   (ii) The velocity at t = 4.5 mins

   (iii) The force that kept the car moving, assuming friction is negligible

2. A gun inclined at 45° to the horizontal was shot into the air. The bullet was released at 30ms⁻¹.

   Calculate

   (i) The maximum height reached by the bullet $= 22.96m$

   (ii) The horizontal range $\frac{u^2 \sin 2\theta}{g} = 91.84m$

   (iii) The time taken to reach the maximum height $T = \frac{u \sin\theta}{g}$ $H = \frac{u^2 \sin^2\theta}{2g}$ 2.16s

3. In the course of experiments, a student obtained a number of physical equations for the relationships of some physical equations:

   (i) $P = a/v - bv^2$ $P = \frac{a}{v} - bv^2$

   (ii) $2at$ $a\,m - \frac{1}{\sqrt{cp}}$ $PV = a - bv^3$

   v is velocity $ML^{-1}T^{-2} \times L^3 = a$, $= ML^2T^{-2}$

   p represents pressure and t is time. Evaluate the dimensions of the following quantities (i) a (ii) b (iii) m (iv) c

$S = 10.6(300)^2 i + 14.6(300) j$

$31,800 i + 4380 j$

$S = \sqrt{\ldots}$

$= 32\ldots$

$\frac{ds}{dt} = V = 21.2t i + 14.6j$

$V = 5724 i + 14.6 j$

$V = 5724 ms^{-1}$

$a = 21.2$

$f = 21.2$

(6)

(c) A block of wood of mass M_1 = 1kg on an inclined plane of angle 30° tied with a massless 2 metre string to another block of wood of mass M_2 with the string passing over a massless pulley fixed to the top of the plane. If the coefficient of kinetic friction μ between the plane and body M_1 is 0.2, and if M_1 slides down the plane at constant speed, determine

(i) the mass of M_2, (ii) the acceleration of the system and (iii) the tension in the string.

4. (a) Define the vector product of unit vectors i = (1, 0, 0) and j = (0, 1, 0)

(b) A spaceman in training is rotated in a seat at the end of a horizontal rotating arm of length 5m. If he can withstand accelerations up to 9g. hat is the maximum number of revolutions per second permissible. The earth's g may be taken as $10ms^{-2}$.

(c) The displacement of a block attached to a horizontal spring whose spring constant is 12N/m is given by x = 0.2 Cos (4t + 0.8)m. Find at t = 0.1sec.

(i) the mass of the block (ii) the acceleration (iii) the total energy (iv) the period T.

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UNIVERSITY OF IBADAN
DEPARTMENT OF PHYSICS

B.Sc Degree Examinations - 1st Semester 2001/2002

PHY 114 – Mechanics and Properties of Matter

Date: 7th May 2002 Time: 1 ½ hrs.

Answer any TWO Questions

Write your name and Mat. No. on your question paper and on your exam booklet.

1. (a) State two uses of method of dimension analysis.

(b) The wave set-up in a guitar string by plucking it has a velocity, V, where V depends on the tension T in the string, the length L of the string and the mass M of the string. Use dimension analysis to show how V is related to T, L, M.

(c) Two forces $\underline{F}$ and $\underline{G}$ act on a particle. On the x – y plane $\underline{F}$ is 5.2 N at angle 180^0 to the x – axis and $\underline{G}$ is 15 N at angle 30^0 to the x – axis. Determine the magnitude of $\underline{F} + \underline{G}$ and of $\underline{G} - \underline{F}$.

(d) A car of mass 1800kg is lifted at a steady speed by a crane as the car hangs at the end of a cable whose diameter is 1.2cm. the cable is 15m in length and stretches by 8.0mm because of the weight of the car. Determine the stress, the strain and Youngs modulus for the cable.

2. (a) Show that the path of a projectile is parabolic

(b) A jet fighter traveling horizontally with a speed of 4×10^2 km/h at an altitude of 3×10^2m, releases a heavy small iron ball.

(i) How much time elapses before the ball hits the ground?

(ii) What is the speed of the ball just before it hits the ground?

(iii) What is the horizontal distance travelled by the ball?

(c) State the parallel axis theorem

(d) Calculate the moment of inertia of a uniform rod rotating about an axis through its midpoint. Hence, or otherwise calculate its moment of inertia if it rotates about an axis located at 0.2m from its midpoint.

3. (a) State Kepler's laws of planetary motion

(b) Define a Synchronous orbit

(c) A block of wood of mass $M_1 = 1$kg on an inclined plane of angle 30° tied with a massless 2 metre string to another block of wood of mass M_2, with the string passing over a massless pulley fixed to the top of the plane. If the coefficient of kinetic friction μ_k between the plane and body M_1 is 0.2, and if M_1 slides down the plane at constant speed, determine

(i) the mass of M_2, (ii) the acceleration of the system and (iii) the tension in the string.

4. (a) Define the vector product of unit vectors $\underline{i} \equiv (1, 0, 0)$ and $\underline{j} \equiv (0, 1, 0)$

(b) A spaceman in training is rotated in a seat at the end of a horizontal rotating arm of length 5m. If he can withstand accelerations up to 9g, what is the maximum number of revolutions per second permissible. The earth's g may be taken as $10ms^{-2}$.

(c) The displacement of a block attached to a horizontal spring whose spring constant is 12N/m is given by $x = 0.2 \cos(4t - 0.8)$m. Find at t = 0.1sec.

(i) the mass of the block (ii) the acceleration (iii) the total energy (iv) the period T.

UNIVERSITY OF IBADAN

DEPARTMENT OF PHYSICS

B.Sc. Degree Examination 1st Semester 2000/2001 Session

Date: 23rd January, 2001 Time: 1½ hrs.

PHY 114 - Basic Principles of Physics I

ANSWER ANY TWO QUESTIONS.

Write your name and Mat. No. on your question paper.

Where necessary take:

Mass of the Sun = 3.24×10^5 of the mass of Earth

The acceleration due to gravity, $g = 9.80 m/s^2$

Distance of the sun from the Earth = $14.88 \times 10^{10} m$; $G = 6.67 \times 10^{-11} Nm^2 kg^{-2}$

1. (a) Define the dimension of a physical quantity.

(b) If A and B have different dimensions, which of the following operations are possible and why?

(i) $A - 2B$ (ii) $\sqrt{A} - B$ (iii) Tan (AB) + Sin (AB) – 1

(iv) $\frac{(A-B)}{(B-A)}$

(c) The period T of a Satellite depends on its orbital radius r, the universal gravitational constant G and the mass M of the attracting body. Express T in terms of r, G and M.

2. (a) (i) Define a 'rigid body'

(ii) Distinguish between the mass of a body and the moment of inertia of a rigid body.

(b) (i) Show that the acceleration due to gravity of a body within the earth's interior, g'', and that on a body on the earth surface, g relate as $g'' = gy/R_E$, where y is the distance between the center of the body in the earth's interior and the center of the earth, and R_E is the radius earth.

(ii) How far from the earth must a body be along a line toward the sun so that the sun's gravitational pull will be one-third the earth's on the body?

3. (a) State Kepler's second law of planetary motion. How does the validity of the law affect the speed of the planet?

(b) A 1200N slab is pulled along a horizontal surface at uniform speed by means of a rope that makes an angle of 30° above the horizontal. If the tension in the rope is 100N, what is the coefficient of friction of the surface?

(c) Consider two planar vectors $\underline{U}$ and $\underline{V}$ of same magnitude A (i.e $|\underline{U}| = |\underline{V}| = A$). One makes an obtuse ($> \pi/2$) angle β with the other. Show that the magnitude of $\underline{U} + \underline{V}$ is 2 A Cos (β/2) and of $\underline{U} - \underline{V}$ is 2 A Sin (β/2).

4. (a) At what point should a uniform thin stiff bar of length 100cm be supported so that it balances a 10g mass placed at one end, a 60g mass on the other end and a 40g mass 30cm from 10g mass? What is the magnitude of the reaction at the support? (Assume that the bar has negligible weight).

(b) A footballer kicks a ball with an initial velocity of 25.0ms^{-1} at an angle of 30° above the ground, and to his right side. A second footballer standing at 30.0m to the right of the first footballer runs uniformly to catch the ball just before it hits the ground. Ignoring air effects, calculate

(i) the time of flight of the ball;

(ii) the distance covered by the second footballer to catch the ball;

(iii) the speed at which the second footballer runs;

(iv) the velocity of the ball (magnitude and direction) just before landing.

(c) Show that the periodic time T of a Conical pendulum is given by

$T = 2\pi(LCos\theta/g)^{1/2}$, where L is the length of string, θ is the angle the string makes with the vertical and g is the acceleration due to gravity.

PHY 114

1. Two cars took off from Ibadan at the same speed of $120kmh^{-1}$, one travelling to Abuja and the other to Lagos. They naturally have the same velocity.
   a) True b) false c) most of the time
   d) *only if their speed is constant through the journey*
2. Which of the following statements is not true?
   a) Scalar quantities can be specified by magnitude only
   b) Vector quantities can be added geometrically and analytically
   c) The magnitude of the velocity of a body moving in a circular path is the same as that of its speed
   d) Scalars and vectors must be added in the same way.

Use the information below to answer questions 3 – 5.
Two forces $\vec{A}$ and $\vec{B}$ are 6N at 36° to the positive x-axis and 7N along the negative x-axis respectively

3. The magnitude of $\vec{A} + \vec{B}$ is
   a) 3.79N b) 2.79N c) 0.59N d) 12.37N
4. The direct of $\vec{A} + \vec{B}$ is
   a) N31.3°E b) N31.3°W c) N58.7E d) N58.7N
5. The magnitude of $\vec{A} - \vec{B}$ is
   b) 2.797N b) 12.37N c) 3.87N d) 0.59N
6. Which of these statements is/are correct?
   i) Kinematics is the study of motion without reference to the cause of the motion
   ii) Dynamics is the study of motion with reference to the cause of motion
   iii) Kinetimatics and dynamics are both branches of mechanics in physics
   iv) Only number (iii) above is correct.
   a) i) and ii) only b) iv only
   c) i) and (iv) only d) ii), iii) and iii) only

Use the information below t answer questions 7 – 10
A car starting from rest attains a speed of 120kmh-1 in 10 sec. It then continues with this speed for 10 minutes after which it is brought to rest in another 10 minutes.

7. The acceleration in the first segment of the journey is
   a) $33.3kms^{-1}$ b) $50.0kms^{-2}$ c) $5.0ms^{-2}$ d) 3.33ms
8. The acceleration in the second segment is
   b) $2.3ms^{-1}$ b) $0.06ms^{-2}$ c) $0.00ms^{-2}$ d) $10.0ms^{-2}$
9. The distance travelled in the last segment of the journey is
   a) 10km b) 9.9km c) 19.9km d) 20.0km

10. The total distance travelled in all the three segments of the journey is

a) 36.1km b) 30.1km c) 33.1km d) 10.5km

11. Which of the following statement is/are not correct

i) Projectile motion is an example of motion in a plane

ii) Projectile motion can be described in terms of time, horizontal and vertical displacements

iii) Both vertical and horizontal velocities of projectile change in the course of motion

a) iii only b) ii and iii only c) I only d) ii only

12. The force $\vec{F}$ between two points masses m_1 and m_2 separated by a distance r is given as

$F = \frac{Gm_1m_2}{r^2}$, the dimension of G in this equation is

a) Nm^2kg b) $L^3M^{-1}T^{-2}$ c) $L^2M^{-2}T^{-1}$ d) $L^3M^{-1}T^{-1}$

13. Which of these statements is/are true

i) An object is an equilibrium when it moves with constant velocity

ii) The apparent weight is the force that an object excert on the platform of a scale

iii) Apparent weight is always greater than true weight

a) i) only b) ii and iii only c) iii only d) i and iii only

14. Which of these statements is/are false?

i) Work done by a force may be positive or negative

ii) Positive work done may indicate increase in kinetic energy

iii) It is not possible to have negative work done.

a) iii only b) I only c) ii only d) I, ii and iii

15. A body of mass 2kg initially at rest is acted on by a force $F = 55 + t^2N$. the velocity of the body at t = 5 second is

a) $148.3ms^{-1}$ b) $120ms^{-1}$ c) $158.3ms^{-1}$ d) $5ms^{-1}$

16. Which of the statement is/are not true of uniform circular motion?

i) The centripetal and centrifugal forces are always directed towards the entre

ii) Orbiting of satellites is an example of uniform circular motion

iii) The centre petal force is given as $\frac{mv^2}{r^2}$ where m, v and δ have their usual meaning

a) i only b) ii only c) i and ii d) iii only

17. A simple harmonic oscillator has a period of 0.001 seconds and an amplitude of 0.4m. the magnitude of its velocity at the centre of oscillation is

a) $40ms^{-1}$ b) $800\pi ms^{-1}$ c) $400ms^{-1}$ d) $1000ms^{-1}$

18. Which of the following is not true about Newton's third laws of motion?

a) Every object has a form of inertia
b) Forces always exists in pairs
c) Acceleration of an object is directly proportional to the net force acting on the object
d) None of the three laws is applicable in collision problems

19. A ball of mass 0.1kg moving with a velocity of $6ms^{-1}$ collides with another ball of mass 0.2kg at rest. Calculate their common velocity if both move together after collision.

a) 4 ms^{-1} b) 2 ms^{-1} c) $0.2ms^{-1}$ d) $0.18ms^{-1}$

20. At a distance 2R from the centre of the earth the weight of the body is 2.5N. What will be its weight at a distance 3R from the centre of the earth?

a) 4.75N b) 3.75N c)1.1N d) 0.8N

21. A particle of mass 0.2kg attached to the end of a string is whirled in a vertical order of radius 2.0m at a constant speed of $5ms^{-1}$. What is the tension in the string at the highest point on its path?

a) 2.5N b) 0.5N c) 12.5N d) 4.5N

Use the following to answer questions 22 to 24

A car of mass 2.0×10^3kg is travelling to the north and at a sped of $15ms^{-1}$

22. The momentum of the car is

a) 3.00 x $10kgms^{-1}$ b) 1.5 x 10^4kgms^{-1}
c) 3.0 x 10^4kgms^{-1} d) 3.0 x 10^4kgms^{-1} due north

23. If the velocity is tripled, by what factor does the momentum increased?

a) 3 b) 2 c) 4 d) 9

24. If the velocity is tripled by what factor does not the kinetic energy increase?

a) $^1/_3$ b) 3 c) 9 d) 6

25. Two arrows, mass 0.1kg each are shot horizontally with the same speed of 30ms-1, one from east and the other form south meeting at a point. Find the magnitude and direction f the total momentum of both arrows

a) $4.2kgms^{-1}$ Northwest b) 4.2 $kgms^{-1}$ southwest
c) $3.0kgms^{-1}$ 40° Northwest d) None of the above

Use the problem below to answer questions 26 and 27. Two cars A and B are moving in the same direction along a straight line. Car A has four times the momentum and twice the kinetic energy of B.

26. Determine the ratio of mass of A to that f B

a) 4 b) 2 c) 8 d) 16
b)

27. The ratio of velocity of A to B is

a) ½ b) 2 c) 4 d) 8

Use the problem below to answer questions 28 – 32

A disc of mass 20kg and radius of 0.15m is mounted on a horizontal cylindrical axle of radius 0.015m and of negligible mass N$_o$ frictional losses exist between the strings. Calculate

The momentum of inertial of the disk

a) 20.5 $kgms^{-1}$ b) 22.5 x $10^{-2}kgms^{-2}$

c) 2.25kgm^2s^{-1} d) 2.25 x $10^{-3}kgms^{-1}$

28. The torque due to 20N force applied tangentially to the axle

a) 4.5Nm b) 33.0Nm c) 3.0Nm d) 0.3Nm

29. The angular velocity is the 20N force is applied for 12 seconds

a) 16.0$rads^{-1}$ b) 18.0m^{s-1} c) 18.0$rads^{-1}$ d) 160.o$rads^{-1}$

30. The kinetic energy of the disc at the end of the 12 seconds

a) 22.8J b) 28.8J c) 2880J d) 280.8K

31. The time required to bring the disc to rest if a breaking force of 1N were applied tangentially to its rim

a) 240.0s b) 2400.0s c)24.0s d)12.0s

32. Which of these statements is not true when subtracting vector $\vec{B}$ from vector $\vec{A}$. We can simply reverse the direction of $\vec{B}$ and add it to $\vec{A}$.

a) We simply reverse the direction of $\vec{B}$. and add it to $\vec{A}$

b) We can use parallelogram law

c) We can use analytical method

d) We simply subtract both the magnitude and direction of $\vec{B}$ and that of $\vec{A}$

33. Which of these statements are correct

i) A rigid body is in equilibrium if its translational acceleration is zero

ii) If its angular acceleration is zero

iii) If the vector sum of all the forces acting on the body is constant

iv) If the net torque acting on the body is zero

a) i, ii and iv only b) i and ii only

c) i and iv only d) i, iii and iv only

34. A force bi + 4j – 10k acts tangentially to the circumference of a disc of radius 2i + j + 3k. Find the torque.

a) 2i – 2j + 14k Nm b) 22i – 38j – 2kNm

c) 46.13Nm d) 22i – 2j + 14kNm

35. Which of these has the same unit as Youngh Mofulus of elasticity

a) Strain b) stress

c) strain.stress d) $\frac{(\text{stress})^2}{\text{strain}}$

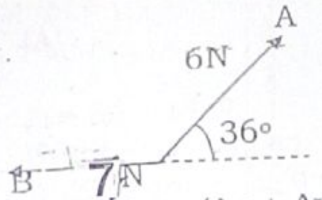
36. A metal rod 1m long and 0.5cm2 cross sectional area is found to stretch by 0.2cm. calculate the force on the rod of the Young's modulus of the metal is $2.0 \times 10^{11} Nm^{-2}$
 a) 2.0×10^{-19}N b) 5.0×10^{-3}N
 c) 2.0×10^{-3}N d) 5.0×10^{-9}N
37. A muscle requires a force of 50W for an elongation of 4cm. regarding the muscle as a uniform elastic cylinder, calculate the energy stored in it.
 a) 1J b) 2J c) 4J d) 8J
38. The study of surface tension is applicable to
 a) Liquid only b) solids only
 c) liquids and solids only d) liquids, solids and gases
39. At the terminal velocity, a solid moving through a fluid has a
 a) Uniform velocity and all the force must be balance
 b) Uniform velocity but all the forces do not balance
 c) Velocity changing uniformly and all the forces on it balance
 d) Velocity changes uniformly but all the forces on it do not balance

Solutions to PHY 114

1. B. P. velocity will only be the same if they follow the same direction with equal speeds.

2. (D)

3.



$\vec{A} + \vec{B} = (Ax + Ayi) + Bxi + Byi)$

$Ax = 6N\cos 36^\circ = 4.854i$

$Ayi = 6N\sin 36^\circ = 3.526i$

$Bx = 7N\cos + 80^\circ = 7i$

$By = 7N \sin 180^\circ = 0j$

$\vec{A} + \vec{B} = (4.854i + 3.526i)$
$\quad + \quad (-7i \quad 0j)$

$\vec{A} + \vec{B} = 2.146i + 3.526j$

$\left|\vec{A} + \vec{B}\right| = \sqrt{-2.146^2 + 3.526^2}$

$\left|\vec{A} + \vec{B}\right| = 2.737$ (A)

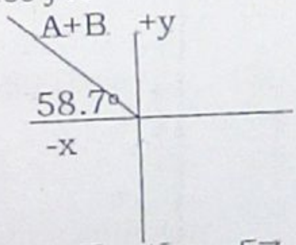
4. $\tan\theta = {}^{j}/_{i}$

$\theta = \tan^{-1}({}^{j}/_{i})$

$\theta = \tan^{-1}\left(\frac{3.526}{2.146}\right)$

$\theta = 58.67^\circ \simeq 58.7^\circ$

Since j is + ve and I is –ve $\vec{A} + \vec{B}$ is in second quadrant



Hence direction of $\vec{A} + \vec{B}$ = N31.3°W

5. $\vec{A} + \vec{B} = \vec{A} + (-\vec{B}) =$

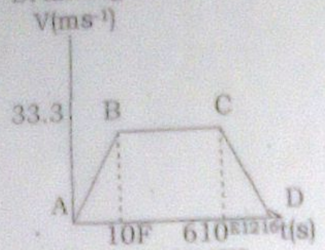
if $\vec{B} = (-7i - oj)$

$\vec{A} + (-\vec{B}) = (4.854i + 3.526j) + (7i - oj)$

$\vec{A} + \vec{B} = 11.854i + 3.526j$

$\vec{A} + \vec{B} = \sqrt{11.854^2 + 3.526^2}$
$\vec{A} + \vec{B} = 12.367 \simeq 12.37N$

6. (D)
Di among the velocity time graph



$120kmh^{-1} = \frac{120 \times 1000}{3600}$
$= 33.33ms^{-1}$

7. Acceleration in front seq
$A = \frac{v-k}{6} = \frac{33.33-0}{10}$
$= 3.333ms^{-1}$ (D)

8. Velocity in second seq is constant $\Rightarrow a = 0$ (C)

9. Distance in last seq = Area of triangle CDE

$= \frac{1}{2} \times 600 \times 33.333.33$
$= 10000m = 10km$ (A)
(Note 33½ must be used)

10. Total distance = area under curve = Area of traperzium ABCD
$= \frac{1}{2}(BC + AD) \times 33^1/_3$
$= 3016m \simeq 301km$ (B)

11. (A)

12. $G = \frac{F \times r^2}{m_1 m_2} = \frac{Fr^2}{m^2}$
G = Mass x Acceleratiion x (length)^2
X(Mass)$^{-2}$
$G = MLT^{-2} \times L^2 \times M^{-2}$
$G = M^{-2} \times L^3 \times T^{-2}$
$G = L^3 \times M^{-1} \times T^{-2}$ (B)

13. (A)
State (i) is correct for dynamic equilibrium
(ii) It actual weight not apparent weight
(iii) Apparent weight is always lesser (Diff between N and true weight).

14. (A)

15. $F = 55 + t2\ N$ .... (i)
(Note FDt = mDv)
Integrating eqn (i) with respect to t
$\int F dt = \int (55 + t^2) dt$
$FDt = 55t + \frac{t^2}{3} = mDv$
When t = s
MDV = 316.66
$DV = {}^{316.66}/_{2} = 158.3$
Since u = o (from rest)
DV = v – u
$\Rightarrow V = DV = 158.3$ (C)

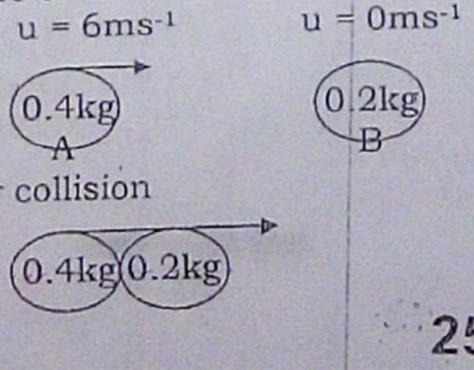
16. (B)

17. $V = w\sqrt{A^2 - x^2}$ at centre x = 0
V = wA
$w = {}^{2\lambda}/_{T} = \frac{2\lambda}{0.001} = 2000\lambda$

$v = 2000\lambda \times 0.4$
$= 800\lambda ms^{-1}$ (B)

18. (D)

19. Before collision



A B

From the principle of conservation of mom

Mom before = mom after

$m_1u_1 + m_2u_2 = (m_1 + m_2)V$

$v = \frac{m_1u_1}{(m_1 + m_2)}$ $(u_2 = 0)$

$v = \frac{0.1 \times 6}{(0.1+0.2)} = 2ms^{-1}$ (B)

20. B

21. At highest point, tension is the vector sum of the weight and centrifugal force

$T = mw^4r - mg$ (F_g and W are opp)

$T = m(w_2r - g)$

$T = 0.2\left(v^2/_{r^2 \times r} - g\right)$

$T = 0.2\left(\frac{v^2}{r} - g\right)$

$T = 0.2\left(\frac{5 \times 5}{2} - 10\right)$

$T = 0.5N$ (B)

22. Mom = mv = 2.0 x 103 x 15

= $3.0 \times 10^4 kgms^{-1}$ due north

= $3.0 \times 10^4 kgms^{-1}$ due north (D)

23. Mom is directly proportional to net, hence if velocity is tripled momentum increases by a factor of 3 (A)

24. K.E α v^2 [K.E = $\frac{1}{2}mv^2$]

If velocity is tripled, the K.E increases by a factor of 9 (C)

25. A

26. and 27.

Momentum of A = M_AV_A

Momentum of B = M_BV_B

$M_AV_A - 4M_BV_B$ .... (i)

K.E of A $\frac{1}{2} M_AV_A^2$

K. E of B = $\frac{1}{2} M_BV_B^2$

$\frac{1}{2} M_AV_A^2 = (\frac{1}{2} M_BV_B^2) \times 2$

$\frac{1}{2} M_AV_A^2 = M_BV_B^2$

$M_A V_A^2 = 2M_B V_B^2$ .... (ii)

Divide eqn (i) by (ii)

$$\frac{M_A V_A}{M_A V_A^{\ 2}} = \frac{4M_B V_B}{2M_B V_B^{\ 2}}$$

$$\frac{1}{V_A} = \frac{2}{V_B}$$

$V_B = 2V_A$ .... (iii)

$V_A/V_B = 1/2$

Put eqn (iii) in (i)

$M_A V_A = 4M_B 2V_A$

$$\frac{M_A}{M_B} = \frac{8V_A}{V_A}$$

$M_A/M_B = 8$

26. 8 = C

27. ½ = A

28. Moment of inertia I

$I = ½Mr^2$ (Disc)

$= ½ \times 2.0 \times 0.15^2$

$I = 0.225 = 22.5 \times 10^{-2}$

$I = 22.5 \times 10^{-2} kgm^2$ (B)

29. Torque $\tau = F \times r$

$= 20 \times 0.015$

$= 0.3Nm$ (D)

30. $16.0\ rad s^{-1}$ (A)

31.

K.E = ½ mv2

= ½ mw2 x 2

= ½ mx2 = I

SO, K.E = IW2

$= ½ \times 22.5 \times 10^{-2} \times 16^2$

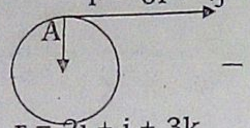
K. E = 28.8J (B)

32. **A**

33. (A)

34. (A)

35. F = 6i + 4j – 10k



r = 2i + j + 3k

Torque = Fxr

	+ i	- j	+ k
F	6	4	-10
r	2	t	3

Fxr = + [(4 x 3) – (-10 x 1)]i – [(6 x 3) – (2 x 4)]

Fxr = [10 + 12]i - [13 + 20]j + [6 - 8]k

Fxr = Torque = 22i – 38j – 2k Nm

Torque = 22i – 38j – 2k Nm (B)

36. Stress = $^{force}/_{area}$ = Nm^{-2}

Young Modulus = $\dfrac{^{force}/_{area} = ^{N}/_{M^2}}{\frac{extension}{length} \quad = ^{m}/_{m}}$

Unit = Nm^{-2} (B)

37. Y = $^{F}/_{A}$ x $^{L}/_{C}$ = $^{FL}/_{AC}$

$F = \frac{YA_c}{L} = Z$

$F = \frac{2.0\ 10^{11}\ 0.5 x 10^{-4} x\ 0.2 x 10^{-2}}{1}$

F = 2.0 x 10^3N (C)

38. F = Ke **{HOOKE'S Law}**

E = ½ x 50 x 4 x 10^{-2} = IJ (A)

39. A

40. A

PHY 114

1. The respective dimensions for frequency, energy and pressure are
   a) T, ML^2T^2, $ML^{-1}T^{-2}$ b) T^{-1}, ML^2T^2, $ML^{-1}T^{-2}$
   c) T^{-1}, ML^2T^{-2}, $ML^{-1}T^{-2}$ d) T, ML^2T^{-2}, $ML^{-2}T^{-2}$
2. Which of the set of quantities have the same basic units?
   a) Power, work, moment b) work, moment, momentum
   c) moment, work and energy d) work, energy and power
   e) none of the above
3. Given that E = $\sqrt{2/_t}$ where q has the dimension of energy and it has the dimension of time. What is the dimension of E?
   a) $M^{-2}T^{-2}, L^2T^3$ b) $M^{-½}L^{½}T^{½}$
   c) $M^{-3/2}L^{½}T^{½}$ d) $M^{-½}LT\ M^{-3/2}$
4. If vector A has components Ac = 3.2m and Ay = 1.6m. find the components Gx and Cy of vector C which is perpendicular to A if C has a magnitude of 5.0m?
   a) Cx = 2.0m and Cy = 5m b) Cx = 10m and Cy = 2m
   c) Cy = $\sqrt{5m}$ and Cx = $\sqrt{5m}$ d) Cx = $\sqrt{15m}$ and Cy = $\sqrt{10m}$
   e) Cx = $\sqrt{5m}$ and Cy = $\sqrt{20m}$
5. Two vectors P and Q are given as P = 3i – 4J + 5k and Q = 2j + 2k respectively. Find P. Q
   a) 1 b) 5 c) 2 d) -4
6. A body moving along the ace has its motion described by the equation X = 40t + 5t². What is the average velocity of the body during the first 5 seconds of its motion?
   a) 325ms⁻¹ b) 5ms⁻¹ c) 25 ms⁻¹ d) 65 ms⁻¹
7. A stone is projected from a surface at an angle of 30o to the horizontal and with an initial velocity of 40.0m/s. calculate the vertical component of the stones velocity 2.0s after leaving the surface if g = 9.8 ms^{-2}
   a) 0.1 ms^{-1} b) 0.2m/s c) 0.3m/s d) 0.4m/s e) 0.5m/s
8. A body moves from r_1 = 2i + 3j + k to r_2 = 3i – 2j-k (in metres) under the action of a force F = 2i – 3j + k (in Newtons). Find the work done by the force
   a) 10J b) 15J c) 20J d) 23J e) 32J
9. An alternative definition f impulse is
   a) A change in velocity
   b) Change in acceleration
   c) Change in momentum
   d) Change in torque

c) Change in energy

10. An object is found to have a position vector r = (4350 + 50t)I + 7000j + 2k with r in metres and t in seconds. If the mass of the object is 50kg. What is the momentum?

a) 50j kgm/s b) 2500i kgm/s c) 50i $kgms^{-1}$
d) 4000$kgms^{-1}$ e) 5000i kgm/s

11. Calculate the speed of an artificial satellite of mass in places in a circular orbit of 180km above the surface of the earth. [Mass of the earth Me = 5-98 x 10^{24} kg]. Radius of the earth re = 6.38 x 106m and gravitational constant G = 6.67 x $10^{11}Nm^2kg^{-2}$]

a) 5.6 x 10^3m/s b) 7.0 x 10^{14}m/s
c) 7.8 x 10^{14}m/s d) 7.9 x 10^3m/s

12. The velocity of a particle in a simple harmonic motion has a maximum magnitude when

a) The particle displacement from the position of equilibrium is maximum
b) The particle displacement from the position of the equilibrium is zero
c) The particle potential energy is maximum
d) The particle acceleration in maximum
e) None of the above occurs

13. Which of the following system is not in oscillatory motion?

a) Atom in a solid
b) Electrons in the antennas of radio and television transmitters
c) Guitars strings which are plucked
d) Balance wheel of a wrist watch

14. How much pressure is needed to compress the volume of an iron block by 0.11% is the bulk modulus of iron is 90 x 10^9Nm^{-2}?

a) 7.5 x 10^7Nm^{-2} b) 8.0 x 10^8Nm^{-2} c) 9.9 x 10^7Nm^{-2}
d) 7.5 x 10^9Nm^{-2} e) 9.9 x $10^{-13}Nm^{-2}$

15. A 0.2kg billard ball was hit with a rod such that it moved with a velocity of $3ms^{-1}$. If the impact between the ball lasted for 10^{-2}s, the impulsive force is

a) 0.6N b) 0.4N c) 0.006N d) 4.0N e) 60N

16. A girl drop a bag inside a moving train. Her friends saw this helper from a platform. The bag drops 1m from rest when the train is moving steadily along the platform at $2ms^{-1}$. How long does it take for the body t reach the floor of the train?

a) 0.19s b) 0.45s c) 0.35s d) No answer

17. From question 16, calculate the resultant velocity just before it hits the ground

a) $2.0ms^{-1}$ b) $4.4ms^{-1}$ c) $4.8 ms^{-1}$ d) $0.735 ms^{-1}$

18. The human adult tibia contracts by about 1mm per 1000N applied force. By how much is the tibia of 75kg man contracts?

a) 0.75mm b) 0.735mm c) 0.735mm d) 0.735cm

19. A satellite weighs 80N at the earth's surface. If R is the earth's radius, at what distance from the earth centre would the weight of the satellite by 20N?

a) $^{R}/_{2}$ b) $^{R}/_{4}$ c) 2R d) 4R

20. Calculate the least kinetic energy that must be given to a mass 2000kg at the earth's surface for the mass to reach a point a distance 9000km from the center of the earth G = 6.7 x 15^{11}Nmkg M = 6 x 10^{24}kg R = 6.4 x 10^{6}m

21. Calculate the mass f the earth giving that the radius of the earth is 6400km g = 9.8ms^{-2} G = 6.7 x $10^{-11}$$Nm^{2}kg^{-2}$

a) 5.99a x 10^{18}kg b) 5.991 x 10^{27}kg

c) 5.991 x 10^{24}kg d) 5.99 x 10^{27}g

22. A skaler brings her hands and legs close to her body so as to

a) Increase her moment of inertia

b) Increase the torque f her body

c) Reduce angular momentum

d) Reduce angular velocity

23. A flywheel completes 90 revolution in 30 seconds. What is the kinetic energy of the flywheel. Moment of inertia is 0.32kgm^{-2}

a) 18.852J b) 5.76J c) 56.85J d) 113.73J

24. At the Olympic high diving competition, a diver from the top board curves her body in order to

a) Dive into the water with her legs b) Spin more

c) Increase her speed d) Increase her energy

25. What is the period of revolution of a spy satellite in a low earth orbit a distance 7100km from the centre of the earth when the grantation field strength is 8.0Nkg^{-1}

a) 5900hrs b) 900min c) 570secs d) 1hr 38 mins

26. Which of the following is not true about performing arcular motion?

a) The weight of the body equals centripetal force

b) Acceleration is always directed towards the centre

c) The speed and velocity are constantly changing

d) None of the above

27. A stationary mass explodes into two parts, 4 unit and 40 units respectively. If the larger mass has initial K.E of 100J what is the initial K.E of the smaller mass?

a) 10kJ b) 1000kJ c) 100kJ d) 1kJ

28. Which of these does not represent work done?
a) Area under a pressure volume graph
b) Area under mass-volume graph
c) Area under a force-displacement graph
d) Area under a power-time graph

29. A man of mass 70kg walks at a uniform speed of $2ms^{-1}$ across a bridge 40m long and which has a mass of 1000kg. find the reaction at the ends A and B of the bridge if the mass stands at A.
a) A = 5000N B= 5700N b) 5700N B = 5000N
c) A = 10700N B = 5700N d) A = 5700N B = 10700N

30. Two bodies of masks 2kg and 3kg are connected by an inextensible rope over pulley calculate the acceleration if the system assuming the pulley is fractionless
a) $1.96ms^{-1}$ b) $1.96ms^{-1}$ c) $0.51ms^{-1}$ d) $0.51ms^{-1}$

31. An automobile travels up a hill at constant speed of 40km/h and returns down the hill at a constant speed of 70km/h. calculate the average speed round the trip.

32. Find the average velocity from number 31 above.

33. The position of a particle moving along the k axis is given in centimeters by x = 9.75 +1.50t3 where t is in seconds. Calculate the instantaneous velocity when the particle is mid way between its positions at t = 2.00s and t = 3.00s

34. A simple harmonic oscillator has a period of 0.025 sec and an amplitude of 0.4m. the magnitude of its velocity at the centre of oscillation is
a) $25272.73ms^{-1}$ b) $2000ms^{-1}$ c) $1800ms^{-1}$ d) $1600ms^{-1}$

35. If $\vec{d_1}$ = 3i − 2j + 4k and $\vec{d_2}$ = -5i + 2_1 − k. What is ($\vec{d_1}$ + $\vec{d_2}$). (D_1 x4$\vec{d_2}$)
a) 15 b) 0 c) 6 d) -24i − 68j − 16k

36. Three vectors are given by $\vec{a}$ = 3.0i + 5.0j and b = -1.0i − 4.0j + 2.0k and $\vec{c}$ = 2.0i + 2.0j + 1.k find $\vec{a}$ ($\vec{b}$ x $\vec{c}$)
a) 6 b) -24i + 25j c) -8i + 5j + 6k d) 1

37. The position $\vec{r}$ a particle moving in an xy plane is given by $\vec{r}$= $(2.00t^{3} - 5.00t)I + (6.00 - 7.00t^{4})j$ with r in metres and time in seconds. In unit vector notation calculate $\vec{a}$ at t = 2.00s
a) 72i – 336j b) 36i – 84j c) 36t + 336j d) 721i + 336j

38. What is the angle between the positive direction of the x-axis and a line tangent to the particles path at r = 2.00s?
a) 77.90 b) 282.1° c) 75.40 d) 284.6°

39. A ball is shot from the ground into the air. At a height 9.1m, its velocity is $\vec{v}$=(7.6i + 6.1j)m/s with I horizontal and j upward. To. what maximum height do the ball rise?
a) 20.4m b) 19.4m c) 19.3m d) 8.5m

40. Young Modules of elasticity is applicable to only
a) Gasses b) liquids c) plasmas d) solids

2

Solutions to PHY 114

1. Frequency = $(\text{Period})^{-1} = T^{-1}$
   Energy = work = F x S = $kgms^{-2} \times m$
   $Kgm^2s^{-2} = ML^2T^{-2}$
   Pressure = $\frac{\text{Force}}{\text{Area}} = \frac{MLT^{-2}}{L^2}$
   $ML^{-1}T^{-2}$
   T^{-1}, ML^2T^{-2}, $ML^{-1}T^{-2}$ **{C}**

2. (C)

3. $E = \sqrt{\frac{\text{Energy}}{\text{Time}}}$
   $E = \sqrt{\frac{\text{Work}}{\text{Time}}} = \sqrt{\frac{F.S}{T}}$
   $E = \left(\frac{F.S}{T}\right)^{1/2}$
   $E = \left(\frac{Kgms^{-2} \times m}{S}\right)^{1/2}$
   $E = \left(kgms^2S^{-3}\right)^{1/2} = \left(ML^2T^{-3}\right)^{1/2}$
   $E = M^{1/2}LT^{-3/2}$ (D)

4.

5. P = 3i – 4j + 5k
   Q = 2j + 2k
   ⇒ Q = 0i + 2j + 2k
   P. Q. = (3i – 4j + 5k)•(0i + 2j + 2k)
   (3 x 0) + (-4 x 2) + (5 x 2)
   = 3 – 8 + 10 = 5 (B)

6. $X = 40t + 5t^2$
   Average velocity
   $V_{avg} = (x_2 - x_1)/t$
   $X_2 = 40(5) + 5(5)^2 = 325m$
   $X_1 = 0$
   $V_{avg} = \frac{325 - 0}{5} = 65ms^{-1}$ (E)

2

Solutions to PHY 114

1. Frequency = $(\text{Period})^{-1} = T^{-1}$
Energy = work = F x S = $kgms^{-2} \times m$
$Kgm^2s^{-2} = ML^2T^{-2}$
Pressure = $\frac{Force}{Area} = \frac{MLT^{-2}}{L^2}$
$ML^{-1}T^{-2}$
$T^{-1}, ML^2T^{-2}, ML^{-1}T^{-2}$ {C}

2. (C)

3. $E = \sqrt{\frac{Energy}{Time}}$
$E = \sqrt{\frac{Work}{Time}} = \sqrt{\frac{F.S}{T}}$
$E = \left(\frac{F.S}{T}\right)^{1/2}$
$E = \left(\frac{Kgms^{-2} \times m}{S}\right)^{1/2}$
$E = \left(kgms^2S^{-3}\right)^{1/2} = \left(ML^2T^{-3}\right)^{1/2}$
$E = M^{1/2}LT^{-3/2}$ (D)

4.

5. $P = 3i - 4j + 5k$
$Q = 2j + 2k$
$\Rightarrow Q = 0i + 2j + 2k$
$P.Q. = (3i - 4j + 5k)\bullet(0i + 2j + 2k)$
$(3 \times 0) + (-4 \times 2) + (5 \times 2)$
$= 3 - 8 + 10 = 5$ (B)

6. $X = 40t + 5t^2$
Average velocity
$V_{avg} = (x_2 - x_1)/t$
$X_2 = 40(5) + 5(5)^2 = 325m$
$X_1 = 0$
$V_{avg} = \frac{325 - 0}{5} = 65ms^{-1}$ (E)

7. $U_y = U\sin t$
$= 40\sin 30 = 20m/s$
$V_y = U_y - gt$
$= 20 - 9.8 \times 2$
$V_y = 0.4$ (D)

8. Work = F.ΔS
$W = (2i - 3j + k)\bullet(r_2 - r_i)$
$r_2 - r_i = (3i - 2j - k) - (-2i + 3j + k)$
$r_2 - r_i = 3i - 2j - k + 2i - 3j - k$
$r_2 - r_i = 5i - 5j - 2k$
$W = (2i - 3j + k)\bullet(5i - 5 - 2k)$
$W = 10 + (15) + (-2)$
$W = 23J$ (D)

9. Impulse = Δ in momentum (C)

10. $r = (4350 + 50t)I + 700j + 2k$
mom = mv
$v = \frac{dr}{dt} = 50i$
momentum = mv = 50 x 50i
$= 2500i\ kgms^{-1}$ (B)

11. $v = \sqrt{\frac{GM_E}{r}}$
where r = distance from earth's centre ⇒ r = R + 180km
r = 6.38 x 106 + 180 000
= 6380000 + 180 000
= 6560000m
$V = \sqrt{\frac{6.67 \times 10^{11} \times 5.98 \times 10^{24}}{6560000}}$
$V = 7.8 \times 1014 ms^{-1}$ (C)

12. (B) i.e. at the centre
When x = 0
$V = w\sqrt{A^2 - x^2}$ if x = 0
$V_{max} = wA$

13. (B)

14. $B = \frac{P}{\Delta V/_V}$

$P = B \times \frac{\Delta V}{V}$

$P = 90 \times 90^9 \times \frac{0.11\%}{V}$

$P = 90 \times 10^9 \times \frac{0.11}{100}$

$P = 9.9 \times 10^7 Nm^{-2}$ (C)

15. $F = \frac{m(v-u)}{t}$

$F = \frac{0.2(3-0)}{10^{-2}}$

$F = 60N$ (E)

16. B 4.87 ms^{-1}

17 C

18. $F = ke$

$e = 1mm = 1 \times 10\text{-}3m$

$k = F/_e = \frac{1000}{1 \times 10^{-3}} = 1 \times 10^6 N/m$

Now, for tibia of 75kg man

$e = \frac{mg}{k} = \frac{75 \times 9.8}{1 \times 10^6}$

$e = 7.35 \times 10^{-4}m = 0.000735m$

$e = 0.735mm$ (C)

19. At the earth surface

$W = m \times 9.8$

$80 = \times 9.8$

$m = (80/9.8)kg$

At a distance h, let g^1 be acceleration due to gravity.

NB: Mass is constant

$20 = \left(\frac{80)}{9.8}\right) \times g^1$

$G^1 = 49/_{20}$

Since g1 is < g. the distance L is outside earth's surface

Apply $g1 = \frac{R^2 g)}{(R+h)^2}$

where R = radius of the earth

$\frac{49}{20} = \frac{R^2 \times 9.8}{(R+h)^2}$

$(R + h)^2 = \frac{R^2}{49/20}$

$R + h = \sqrt{\frac{20 \times 9.8 R^2}{49}}$

$R + h = \sqrt{4R^2}$

$h = \sqrt{4R^2} - R$

$h = 2R - R = R$

h = distance from earth surface

R + h = 2R is the first from its centre (C)

20. $ke = \frac{Gm_m}{r}$

$ke = \frac{6.1 \times 10^{-11} \times 6.0 \times 10^{24} \times 2000}{6.4 \times 10^6}$

$= 12.5\ (25 \times 10^{10})$

21. $G = \frac{GMe}{R^2}$

$Me = \frac{gR^2}{G} = \frac{9.8 \times 6400000^2}{6.7 \times 10^{-11}}$

$Me = 5.99 \times 10^{24}kg$ (C)

22. (B)

23. $K.E = ½ I w^2$

$I = 0.32kgm^{-2}$

w = 90rev/30 seconds

$= \frac{90 \times 2\pi rad}{30 second}$

(Not 1 rev = 2π rad)

$w = 6\pi rads^{-1}$

$K.E = ½ \times 0.32 \times (6\pi)^2$

K.E = 56.85J (C)

24. B

25.

26. (C) The speed is constant but velocity changes continuously since position changes.

27. 4unit mass will have 10 times the velocity of 40 units mass. If velocity increases by 10 unit, and knowing that K.E αV^2. Then K.E increases by a factor of 100.

K. E of 4 unit mass is

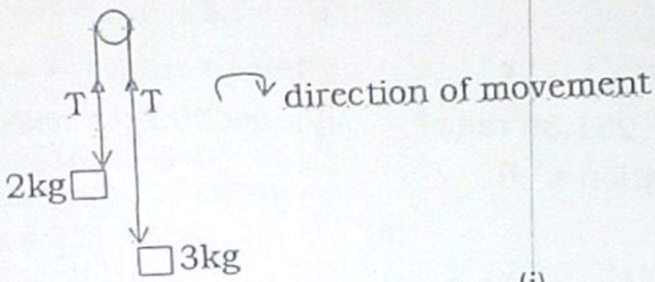
= 100 x 100 = 10000J = 10kJ (A)

28. (B)

29. C

30.

31.



$T - 2 \times 9.8 = 2 \times a$ .... (i)

$-T + 3 \times 9.8 = 3.9$ ________________ (ii)

Eqn (i) + (ii) = $(3.98) - (2 \times 9.8) = 59$

$= 9.8 = 59$

$a = {}^{9.8}/_{5} \quad = 1.96ms^{-2}$ (B)

32 Let t_1 be time when travelling upwards by $40kmhr^{-1}$ and t_2 time when travelling downwards by $70kmhr^{-1}$. (Note distance is equal up and down the hill)

$S_1 = 40t_1$

$S_2 = 70t_2$

But $S_1 = S_2$

$40t_1 = 70t_2$

$T_2 = {}^{4}/_{7}\ t_1$

$T_2 = {}^{40}/_{70}\ t_1$

Average speed $= \frac{\text{Total dist}}{\text{Total time}}$

$= \frac{S_1 + S_2}{t_z + t_z}$

$= \frac{40t_1 + 70({}^{40}/_{70})t_1}{t_1 + \frac{40}{70}t_1}$

$= \frac{80t_1}{\frac{110}{70}t_1}$

$= \frac{70 \times 80t_1}{110t_1} = 50.91kmhr^{-1}$ (D)