

ONLY PASTQUESTION

FOR

PHY 101

EDITED BY HYKE

PAST QUESTION
MEASUREMENT, DIMENSIONAL ANALYSIS AND VECTOR ANALYSIS

1. What are the correct dimension of work and pressure and forces.
2. In a stretched string, the velocity V , of the wave set up by plucking depends on the tension F , in the string, its length L , and is given by $V = KF^x L^y M^z$ where x, y, z are unknown numbers and k is a constant
 - a. Find the values of x, y, z
 - b. Show the relationship between the parameters.
3. Given that the period of oscillation of a pendulum is given by $T = Km^x L^y g^z$ where k is a constant. By finding the values of x, y, z deduce the relation between T and L and g .
4. Derive an expression relating period of vibration with the following: values, a density, ρ , and surface tension Y .
5. A sphere mass $100g$ of radius $a = 2cm$ falling vertically through air of density $= 1.2kgm^{-3}$ at a place where $g = 9.81ms^{-2}$ attains a steady velocity $V = 30ms$. If the retarding force on the sphere is given by $F = Ka^x \rho^y V^z$, where K is constant. Use dimensional analysis to find the values of x, y, z and k .
6. Identify which of the quantities listed below are wholly derived quantities

(i) mass	(ii) Length	(iii) Electric Current
(iv) Density	(v) Temperature	(vi) Velocity
		(vii) Energy
7. Which of the following unit is equivalent to Kgm^{-1}

(a) Ns^{-1}	(b) Pa	(c) J	(d) Nm^{-1}	(e) Js^{-1}
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8. Give the dimension of pressure and Torque
9. A girl X runs with a velocity of $4ms$ across the deck of a ship Y moving in the seas at $3ms$ at 90° to the direction of X , as shown in the figure below
10. When Vector $A = 3i + 4j - 2k$ and $B = 2i - 6j + 3k$ find
 - a. $A \times B$
 - b. Find the angle θ between vector A and B
11. Two vectors A and B are given as follows
 - a. $A = 3i - 5j$ and
 - b. $B = -2.5i + 5j$. Find the magnitude of their vector sum and the angle it takes with the positive x - axis
12. If vector $A = 3i + 4j - 2k$ and $B = 2i - 6j + 3k$ find the scalar product of A and B i.e. $A \cdot B$.
13. Give two vectors $A = 2i + 3j - 4k$ and $B = i - 2j + 3k$, What is the magnitude of each vector.

14. A body mass in an $x-y$ plane such that its velocity has the component $V_x = 5 \text{ m/s}$ and $V_y = 7 \text{ m/s}$. What is the magnitude and direction of the velocity.
15. A vector of magnitude 5 units makes an angle of 30° with the x -axis. Calculate its components along x and y axes.
16. Find the angle between two vectors $A = 2i + 3j + 4k$ and $B = i - 2j + 3k$.
17. Which of the following is / are true of vectors a and b if θ is the angle between them.
- $a \cdot b = ab \cos \theta$
 - $a \times b = ab \sin \theta$
 - $a \cdot b = ab \sin \theta$
18. If $A = 2i + 3j$
 $B = 3i + 5j$
 $C = 4i - 6j$
 find $A \times B \times C$
19. Two forces act on a point object as follows: 100N at 170° and 100N at 50° . Find their resultant.
20. Find the magnitude and angle of $R = 8i - 12j$
21. Find, using dimensional analysis, the relation between the frequency f of vibration of a stretched string and the following parameters: its mass per unit length m , its tension T and its length L .
22. Given the two vectors $A = 6i + 3j - k$ and $B = 4i - 5j + 8k$. Find the magnitude of the vector $2A - B$.
23. Find the angle between the two vectors
 $A = 2i + 3j + k$ and $B = -4i + 2j - k$
24. The viscous Force F on a spherical body of radius r moving with angular velocity ω through a fluid of viscosity η is given by $F = K r^a \eta^b \omega^c$, where K is a dimensionless constant. Using the method of dimensions, determine the value of a, b, c
25. Three vectors are given by
 $A = 3i + 3j - 2k$, $B = -i - 4j + 2k$ and $C = 2i + 2j + k$. Find $A(B \times C)$.
26. Is the expression $P = \frac{1}{2} \rho v^2$ dimensionally correct. Given that P is pressure in Pascal, ρ is density in kg m^{-3} , v is velocity in m s^{-1} and h is the height in meter.

KINETIC (MOTION), PROJECTILE AND FREE FALL

27. The position of an object as a function of time is given by $x = 2t^3 + (t^3 - 5t^2)j$ meters. At time $t = 3 \text{ sec}$. What will be the Object's.
- Speed?
 - Velocity?
 - Acceleration?
28. An object moves such that its displacement as a function of time (in seconds) is $x = 3.0 + 0.2t^4$ meters. Find
- its instantaneous velocity at $t = 3 \text{ sec}$.
 - Its average velocity for time interval 2.0 sec . Centered at $t = 3 \text{ sec}$.
29. An automobile accelerates uniformly from rest to 100 km/hr in 10 sec . Calculate
- Its average acceleration
 - The time to cover the first 100 meters .
30. If an object moves such that its position (in meters) at any time is $x = 20 + 15t + 15t^2$, calculate its
- Instantaneous velocity and acceleration at time $t = 4 \text{ sec}$.
 - Average velocity during the First four seconds.
31. An object is fired vertically upward from the ground with a speed of 50 m/s . Calculate.
- The height to which it rises.
 - How long it takes to reach maximum height.
 - Its speed at the end of third seconds.
 - How far it goes in the third second.
 - The velocity with which it strikes the ground.
32. A ball is thrown up with a speed of 10 m/s at an angle of 30° to the velocity. Find,
- The height to which the ball rise.
 - The time taken to reach maximum height.
 - The horizontal distance covered.

33. omitted
34. An object is thrown up with velocity $V = 5.0i + 8.7j$ in m/s. Find
- The time taken to reach the maximum height
 - The height to which the ball rises.
 - The horizontal distance covered.
35. A river is 1.0km wide and flowing at 1.5km/hr. if a man who can swim at a speed of 2.5km/hr in a pool has to cross the river. Find
- The direction he must head in order to reach a point directly opposite his starting point.
 - The time required to cross the river.
36. The acceleration of a moving object is equal to the _____
37. The position of an object moving along x - axis is given by $x = 6t - 4t^2 = t^3$ where x is in meters and t in seconds. What is the object's displacement and average velocity for the time interval from $t = 3s$ to $t = 5s$.
38. An object's position is initially $r = 5.0i - 6.0j + 2.0k$ and 10s later it is $r = 7.0i - 6.0j - 3.0k$ all in meters. What is the average velocity during the 10s.
39. A particle moving along the x axis is located at $x_1 = 12cm$ at $t = 1s$ and at $x_2 = 4m$ at $t = 3s$. Find the displacement and average velocity during this time interval.
40. An aircraft lands on a runway and decelerates with $10m/s^2$ from 50m/s to 20m/s. Calculate the distance traveled on the runway.
41. Calculate the time taken and the distance covered by a car moving with a velocity of 15m/s to accelerate uniformly at the rate of 2m/s to reach a velocity of 20m/s.
42. A lift is moving down with an acceleration of $3m/s^2$. A ball is released 1.7m above the lift floor. How long will the ball take to hit the floor?
43. A ball is thrown vertically upwards. The quantity which remain the same is _____.
44. A train travels on a straight track passing signal A at 20m/s. It accelerates uniformly at $2m/s^2$ and reaches signal B 100m further than A. At B the velocity of the train is _____.
45. A stone is thrown horizontally with a initial velocity of 20m/s from the top of a building 45m high. Find the horizontal range of the stone.
46. Calculate the velocity with which the stone strikes the ground in question 45.
47. A projectile is launched with a speed of 50m/s at an angle 30° above the horizontal. Determine
- Time of flight
 - Maximum height reached.
 - Horizontal distance (Range) traveled.
48. A coconut is dropped from a tree 45m high with zero initial speed and 0.85 later, a other coconut is thrown vertically downward (with non zero initial speed). If both fruit strike the ground at the same time, calculate the initial speed with which the second coconut is thrown.
49. An aeroplane starts from rest with constant acceleration and runs 40s before taking off, covering a distance of 1200m along its path from the starting point. Calculate its velocity at the instant it takes off.
50. A ball is thrown vertically upward from the ground with a speed of 24.4m/s. How long does it take to reach its highest point and how high does the ball rise?
51. With that speed must a ball be thrown vertically from ground level to rise to maximum height of 50m and how long does it take to get to maximum height.
52. A missile was to be launched at an angle of 30° to the horizontal at an initial velocity V_0 to hit a target 5km away. Calculate V_0 and the maximum height H.
53. A footballer lobs a football at an angle of 35° to the horizontal with an initial speed of 20m/s. What are the greatest height attained and the time of flight?
54. An object is launched to air with an initial velocity $V = (12.5m/s)i + (20.0m/s)j$. Calculate the total time of flight, T and horizontal distance (range).
55. A ball is projected horizontally with velocity V_0 of magnitude 5m/s. Find its position and velocity after $\frac{1}{4}s$.
56. An object is projected horizontally with an initial speed of 15m/s. If the level of projection is 75m above the sea level. Calculate the time taken by the object in the air.

57. A train moving at a speed of 30m/s begins to slow at a constant rate of 2.0m/s each second. How far does it go before stopping?
58. A car moving at 20m/s slows uniformly to a speed of 5m/s in a time of 10s. Determine the distance traveled in the fourth second.
59. A stone is thrown vertically upward with a speed of 20m/s. Calculate the maximum height reached.
60. A car travel for 1200m from rest in one minutes. Calculate the average speed.
61. A car accelerates uniformly at 2.6m/s^2 covering a distance of 70m in 5.4s. Calculate the initial and final velocities.

DYNAMICS (MOTION AND FORCES)

62. A car weighing 12000N accelerates uniformly from rest to 90km/hr in 80seconds. Calculate the average force acting on the car
63. A 5kg body has a velocity $V_0 = 5.0i + 5.0j$ (in m/s). $V = 10i + 15j$. Assuming constant acceleration, what is the magnitude of the force acting on the body.
64. A 0.6kg stone thrown horizontally by a protecting student penetrates 12.0cm into a fresh concrete wall. If the stone has a speed of 5m/s just before hitting the wall. Calculate the resisting force of the wall. Assume that the force is constant.
65. A block of mass 5kg is connected to another block of mass 7kg by a string. The blocks are then pulled apart and released on a smooth horizontal table. If the initial acceleration of the 7.0kg block is 2m/s^2 . What is the initial acceleration of the 5kg block?
66. Two bodies of equal mass of 5.0kg are connected by an inextensible string over a frictionless pulley that is attached to the edge of a table. One body rests on the smooth horizontal table while the other hangs freely. Calculate the acceleration of the bodies and tension in the string when the system is released.
67. Two blocks of mass 8kg and 6kg are connected by a string over a light frictionless pulley at the top of an inclined plane. The 6kg block hangs vertically and the angle of inclination is 30° . Calculate the tension in the string.
68. A 5kg body and 8kg body are connected by a string over a frictionless pulley at the top of a double incline. If the planes are smooth and the angle of inclination are 40° and 30° respectively. Calculate the acceleration of the system when released.
69. A string is suspended from a frictionless pulley that is hooked to a ceiling. To the ends of the string are attached two bodies of masses 6.0kg and 9.0kg. calculate the acceleration of the bodies and the tension in the string when the system is released.
70. A student stands on a scale in an elevator. If the scale reads 640N when the elevator is stationary. What will it read when the elevator is moving upward with
 - a. An acceleration of 2m/s^2
 - b. A constant speed
 - c. A deceleration of 2.0m/s^2
71. A weight of 50N is suspended from a ceiling as shown below. Find the tension in the strings.
72. A force of 60N pulls a body with uniform speed along a horizontal surface. If the force is directed 45° above the horizontal and the coefficient of kinetic friction for the surface is 0.40. What is the weight of the body.
73. The driver of a car traveling at 20km/hr is forced to turn round at that speed. If the car turns through a radius of 8.0m calculate the coefficient of friction μ , between the tires and the road.
74. A force of 20N pulls a block of mass 50kg and overcomes a constant frictional force of 60N. what is the acceleration of the block.
75. A car of mass 1000kg is moving up a hill inclined at 30° to the horizontal. The total frictional force on the car is 1000N. Calculate the force F due to the engine when the car is accelerating at 2m/s^2 .
76. A car of mass 1000kg is accelerating 2m/s^2 . What resultant force acts on the car. If the resistance to the motion is 1000N. what is the force due to the engine.
77. Calculate the constant force that will accelerates a body of mass $2.5 \times 10^3\text{kg}$ from rest to a speed of 50m/s in 20s.
78. A force of magnitude 25N push a block of mass 3.5kg along a frictionless floor by means of a cord which makes angle 60° with the horizontal. Calculate the magnitude of the acceleration of the block.

79. A body of mass 2kg moving with initial speed of 10m/s on a horizontal frictionless plane is pulled 4m by a force of magnitude 25N in the direction of the initial velocity. What is its final speed.
80. A body on which a constant net force of 80N acts, starts from rest and moves 72m in 6s. What is the mass of the body.
81. A horizontal force of 5N is applied to a 200kg block initially at rest on a table with a level surface. What is its acceleration if the coefficient of friction is 0.2.

MOMENTUM AND IMPULSE

82. A tennis ball has a mass of 0.06kg. The impact with a wall changes its velocity from 25m/s towards the wall to 35m/s away from the wall. Determine the impulse the wall exerts on the tennis ball.
83. A man kicks a stationary ball of mass 200g giving it a speed of 100m/s. What impulse is imparted to the ball.
84. A bullet of mass 0.5kg is shot into a 100kg block which is initially at rest on a frictionless horizontal surface. The bullet comes to rest within the block and both slide at 0.4m/s in the same direction as the incoming bullet. Calculate the initial speed of the bullet.
85. Two 2kg bodies, A and B collide. The velocities before collision are $U_A = 15i + 30j$, $U_B = 10i + 5j$ and $V_A = 5i + 20j$ after the collision. All speeds are given in m/s. What is the final velocity V_B .
86. A bullet of mass 0.002kg is fired with a velocity of 800m/s into a soft wood of mass 2kg, lying on a smooth surface. What is the final velocity if the collision is completely inelastic.
87. A constant force acts on a 2kg object and reduces its velocity from 7m/s to 3m/s in a time 3.0sec. What is the magnitude of the force.
88. An 8000kg engine pulls a 40,000kg train along a level track and gives it an acceleration 1.2m/s^2 . What acceleration would the engine give to a 1600kg train.
89. Two inelastic bodies of mass 8kg and 4kg move in opposite directions with velocities 11m/s and 7m/s respectively. Calculate the resultant velocity on collision if they are struck together.

WORK, ENERGY AND POWER

90. A body moves from position $r_1 = 1i + 3j + k$ to $r_2 = 3i - 2j - k$ (in meters). Under the action of a force $F = 2i - 2j - k$ (in newtons) find the work done by the force.
91. A vertical spring is pulled a distance of 20cm below its equilibrium position. If the force constant of the spring is 1000N/m, calculate the work done by the applied force.
92. A body moves with velocity $V = 5i + 2j - 3k$, $F = 4i + 3j - 2k$. What is the instantaneous power.
93. The driver of a 1200kg car traveling at an excessive speed of 120km/hr quickly applies the brake on sighting a parked police vehicle. If the final speed is 90km/hr, calculate the work done in the process.
94. A 6kg body accelerates from a velocity of $2i + 3j + 4k$ to $4i + 6j - 4k$ in 10sec. Calculate the magnitude of the force acting on the body.

CIRCULAR MOTION AND GRAVITATION

95. A 3kg particle, resting on a smooth table and attached to a fixed point on the table by a rope 1.2m long, is making 300rev/min. Find the tension in the rope.
(a) 3600N (b) 360N (c) 36000N (d) 5600N
96. Calculate the period of a conical pendulum of length 16m given that the string turns at a constant angle 60° to the vertical.
(a) 4.2s (b) 3.6s (c) 8.62s (d) 5.62s
97. A spacecraft is in circular orbit about the Earth at an altitude h of 400km. Calculate the orbital speed and the centripetal acceleration if the spacecraft makes one revolution every 85min.
(a) $8.4 \times 10^3\text{m/s}$, 9.8m/s^2 (b) $4.8 \times 10^3\text{m/s}$, 10m/s^2
(c) $8.4 \times 10^3\text{m/s}$, 10.4m/s^2 (d) $4.8 \times 10^3\text{m/s}$, 10.4m/s^2
98. A compact disc accelerates uniformly from rest to angular speed of 400rpm in 2.5s. Calculate the angular acceleration.

- (a) 16.72 rad/s^2 (b) 6.72 rad/s^2 (c) 7.2 rad/s^2
 (d) 16.72 rad/s^2

99. Find the angular speed of any point on one of the blades of a fan turning at a rate of 800 rpm
 (a) 5027.2 rad/s (b) 31.42 rad/s (c) 800 rad/s (d) 10.5 rad/s
 100. Find the tangential speed of the tip of the fan blade in Question 99 if the distance from the centre to the tip is 15 cm.
 101. A car of mass 1200 kg accelerates from rest to a speed of 25 m/s in a time of 8.0 s. What is the average power produced
 (a) 7.1 kW (b) 4.43 kW (c) 47 kW (d) 7.67 kW
 102. Calculate the force required to accelerate a 1300 kg car from rest to a speed of 20 m/s in a distance of 80 m.
 103. A 3.0 kg object is lifted 3.5 m. How much work is done against the Earth's gravity.
 104. A wire is subjected to a tensile stress of $2.5 \times 10^9 \text{ N/m}^2$. Calculate the Young's modulus if the length increases by 5% of its original length.

FLUID PHYSICS

105. In a hydraulic press the large piston has cross-sectional area $A_1 = 5.08 \text{ m}^2$ and the small piston has cross-sectional area $A_2 = 0.13 \text{ m}^2$. If a force $F_2 = 11.34 \text{ N}$ is applied to the small piston. Find the force F_1 on the large piston (a) 443.1 N (b) 0.058 N (c) 400 N (d) 0.098 N
 106. A student observes that 0.24 m^3 of water flows out of a horizontal pipe in 1 min. If the internal diameter of the pipe is 0.05 m. Calculate the speed in the pipe. (a) 0.24 m/s (b) 2 m/s (c) 4 m/s (d) 1 m/s (pg. 140a)
 107. A man's brain is approximately 0.33 m above his heart. If the density of human blood is $1.05 \times 10^3 \text{ kg/m}^3$, determine the pressure required to circulate blood between the heart and the brain.
 108. A swimmer whose body's surface area is approximately 1.6 m^2 lies at a depth of 3 m below the water surface. How much force is exerted on his body due to water pressure.
 109. The pistons of a hydraulic press are of diameter 5 cm and 25 cm. The smaller piston is subjected to a force of 20 N. Determine (a) the pressure transmitted by the fluid and (b) the weight which can be lifted by the larger piston (pg. 92).
 110. The average velocity of water flowing through a 10 cm diameter main pipe is 3 cm/s. (a) What is the flow rate (b) what is the velocity of water flowing out of a 1 cm diameter faucet in the building.
 111. At a certain point in a pipeline where the diameter is 30 cm, the speed of water flow is 1.5 m/s. What is the speed of flow at a point where the diameter is 1 cm.
 112. A horizontal pipe 15 cm in diameter has a constriction of diameter 6 cm. The velocity of water flowing through the 15 cm portion is 2 m/s. Determine (a) the flow rate (b) the velocity at the constriction.
 113. How much work is done in pumping 1.4 cm^3 of water through a 13 mm internal diameter pipe if the difference in pressure at the two ends of the pipe is $1 \times 10^5 \text{ N/m}^2$.
 114. A horizontal pipe of varying cross-section delivers water into a reservoir. At a point in the pipe the pressure is $2 \times 10^4 \text{ Pa}$ and water flows past this point at 1 m/s. Calculate the pressure at another point in the pipe where the velocity of water is 10 m/s.
 115. A pipe of internal diameter 0.04 m is joined to another pipe of internal diameter 0.05 m. If the pipe is horizontal and the rate of flow of water in the pipe is $4 \times 10^{-3} \text{ m}^3/\text{s}$. Find the pressure drop between the two pipes.
 116. Water moving with speed of 5 m/s through a pipe with cross-sectional area of 4 cm^2 gradually descends 10 m as the pipe increases in area of 4 cm^2 gradually descends 10 cm as the pipe increases in area 8 cm^2 . Calculate the speed of flow and pressure at the lower level if the pressure at the upper level is $1.50 \times 10^5 \text{ Pa}$.

ANSWERS TO PAST QUESTIONS

1. Dimension for work, pressure and forces.

$$(a) \text{ Work} = F \times d$$

$$F = ma$$

$$\text{Work} = ma \times d$$

$$W = MLT^{-2} \times L$$

$$W = ML^2 T^{-2}$$

$$(b) \text{ Pressure, } P = \frac{\text{Force}}{\text{Area}}$$

$$P = \frac{F}{A}$$

$$P = \frac{MLT^{-2}}{L^2}$$

$$P = MLT^{-1} T^{-2}$$

- (c) Forces

$$F = ma$$

$$F = MLT^{-2}$$

$$2. V = KF^x L^y M^z$$

$$LT^{-1} = k (MLT^{-2})^x L^y M^z$$

$$LT^{-1} = KM^x L^{1+x} T^{-2x} L^y M^z$$

$$LT^{-1} = KM^{x+z} L^{1+x+y} T^{-2x}$$

Equate the indices on both sides

$$L: 1 = x + y \dots\dots\dots(i)$$

$$T: -1 = -2x \dots\dots\dots(ii)$$

$$x = \frac{1}{2}$$

$$M: 0 = x + z$$

$$\dots\dots\dots(iii)$$

$$0 = \frac{1}{2} + z$$

$$z = -\frac{1}{2}$$

Put $x = \frac{1}{2}$ into equation (i)

$$1 = x + y$$

$$1 = \frac{1}{2} + y$$

$$1 - \frac{1}{2} = y$$

$$y = \frac{1}{2}$$

$$x = \frac{1}{2}, y = \frac{1}{2}, z = -\frac{1}{2}$$

$$V = KF^x L^y M^z$$

$$V = KF^{\frac{1}{2}} L^{\frac{1}{2}} M^{-\frac{1}{2}}$$

$$V = K \sqrt{\frac{FL}{M}}$$

$$3. T = Km^x L^y g^z$$

$$T = KM^x L^y (LT^{-2})^z$$

$$T = KM^x L^{y+z} T^{-2z}$$

$$T = KM^x L^{y+z} T^{-2z}$$

Equate the exponents on both sides

$$T: 1 = -2z \dots\dots\dots(i)$$

$$z = -\frac{1}{2}$$

$$L: 0 = y + z \dots\dots\dots(ii)$$

$$0 = y + (-\frac{1}{2})$$

$$y = \frac{1}{2}$$

$$M: 0 = x \dots\dots\dots(iii)$$

$$T = Km^x L^y g^z$$

$$T = Km^x L^{\frac{1}{2}} g^{-\frac{1}{2}}$$

$$T = K \sqrt{\frac{L}{g}}$$

4. Period T \propto radius a , density ρ , and surface tension Y .

$$T \propto a^x \rho^y Y^z$$

$$T = k a^x \rho^y Y^z$$

$$T = KL^x (ML^{-3})^y (MT^{-2})^z$$

$$T = KL^x M^y L^{-3y} M^z T^{-2z}$$

$$T = KL^{x-3y} M^{y+z} T^{-2z}$$

Equate the indices on both sides

$$T: 1 = -2z \dots\dots\dots(i)$$

$$z = -\frac{1}{2}$$

$$L: 0 = x - 3y \dots\dots\dots(ii)$$

$$M: 0 = y + z \dots\dots\dots(iii)$$

$$0 = y + (-\frac{1}{2})$$

$$y = \frac{1}{2}$$

From equation (ii)

$$0 = x - 3y$$

$$0 = x - 3(\frac{1}{2})$$

$$0 = x - \frac{3}{2}$$

$$x = \frac{3}{2}$$

$$T = Ka^x \rho^y y^z$$

$$T = Ka^{3/2} \rho^{1/2} y^{-1/2}$$

5. Solution

$$F = ka^x \rho^y V^z$$

Dimensionally,

$$MLT^{-2} = KL^x (ML^{-3})^y (LT^{-1})^z$$

$$MLT^{-2} = KL^x M^y L^{-3y} L^z T^{-z}$$

$$MLT^{-2} = KL^{x-3y+z} M^y T^{-z}$$

$$\text{For M: } 1 = y \dots \dots \dots (i)$$

$$L: 1 = x - 3y + z \dots (ii)$$

$$T: -2 = -z \dots \dots \dots (iii)$$

$$z = 2$$

$$1 = x - 3y + z$$

$$1 = x - 3(1) + 2$$

$$1 = x - 3 + 2$$

$$1 = x - 1$$

$$x = 1 + 1$$

$$x = 2$$

$$F = Ka^x \rho^y V^z$$

$$F = Ka^2 \rho v^2$$

$$mg = Ka^2 \rho v^2$$

$$0.1 \times 9.8 = k \times (2 \times 10^{-2})^2 \times 1.2 \times 30^2$$

$$0.98 = k \times 4 \times 10^{-4} \times 1.2 \times 900$$

$$k = 2.269$$

$$k = 2.3$$

6. Density, velocity and energy are derived quantities

7. Option (B) Pascal

$$1 \text{ Pascal} = 1 \text{ N/m}^2$$

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$P = \frac{m \times a}{A}$$

$$P = \text{kg m/s}^2 / \text{m}^2$$

$$P = \text{kg m}^{-1} \text{s}^{-2}$$

$$P = \text{kgm}^{-1} \text{S}^{-2}$$

Dimension of pressure and

Torque

$$(a) \text{ Pressure} = \frac{F}{A}$$

$$P = \frac{MLT^{-2}}{L^2} \quad P = ML^{-1}T^{-2}$$

- (b) Torque = Force x distance

$$T = MLT^{-2} \times L$$

$$T = ML^2 T^{-2}$$

9. Using pythagoras theorem,

$$V = \sqrt{4^2 + 3^2}$$

$$\tan \theta = \frac{V_y}{V_x} = \frac{4}{3} = 1.333$$

$$\theta = \tan^{-1}(1.333)$$

$$\theta = 53^\circ$$

$$\theta = 53^\circ$$

10. $A = 3i + 3j - 2k$

$$B = 2i - 6j + 3k$$

$$ax = 3, \quad ay = 4 \quad az = -2$$

$$bx = 2, \quad by = -6 \quad bz = 3$$

$$A \times B = (4 \times 3 - (-2 \times 6))i + (-2 \times 2 - 3 \times 3)j + (3 \times (-6) - 4 \times 2)k$$

$$A \times B = (12 - 2)i + (-4 - 9)j + (-18 - 8)k$$

$$A \times B = 0i + (-13)j + (-26)k$$

$$A \times B = -13j - 26k$$

11. $A = 3i - 4.5j$

$$B = -2.5i + 5j$$

$$A+B = (3i-4.5j) + (-2.5i+5j)$$

$$A+B = (3+-2.5)i + (-4.5+5)j$$

$$A+B = 0.5i+0.5j$$

$$A+B = C$$

$$|C| = \sqrt{0.5^2 + 0.5^2}$$

$$|C| = \sqrt{0.5} = 0.71$$

$$\tan \theta = \frac{y}{x} = \frac{0.5}{0.5} = 1$$

$$\theta = \tan^{-1}(1)$$

$$\theta = 45^\circ$$

12. $A = 3i + 4j - 2k$

$$B = 2i - 6j + 3k$$

$$A.B = axbx + ayby + azbz$$

$$ax = 3, \quad ay = 4, \quad az = -2$$

$$bx = 2, by = -6, bz = 3$$

$$A \cdot B = (3 \times 2) + (4 \times -6) + (-2 \times 3)$$

$$A \cdot B = 6 + (-24) + (-6)$$

$$A \cdot B = -24$$

$$13. A = 2i + 3j - 4k$$

$$B = 1 - 2j + 3k$$

$$|A| = \sqrt{ax^2 + ay^2 + az^2}$$

$$|A| = \sqrt{2^2 + 3^2 + (-4)^2}$$

$$|A| = \sqrt{4 + 9 + 16}$$

$$|A| = \sqrt{29} = 5.4$$

$$|B|^2 = bx^2 + by^2 + bz^2$$

$$|B| = \sqrt{1^2 + (-2)^2 + 3^2}$$

$$|B| = \sqrt{1 + 4 + 9}$$

$$|B| = \sqrt{14}$$

$$|B| = \sqrt{3.74}$$

$$14. |V| = \sqrt{V_x^2 + V_y^2}$$

$$|V| = \sqrt{5^2 + 7^2}$$

$$|V| = \sqrt{25 + 49}$$

$$|V| = \sqrt{74}$$

$$|V| = 8.6 \text{ m/s}$$

Direction α is

$$\tan \alpha = \frac{V_y}{V_x}$$

$$\tan \alpha = \frac{7}{5}$$

$$\tan \alpha = 1.4$$

$$\alpha = \tan^{-1}(1.4)$$

$$\alpha = 54.5^\circ$$

$$15. \text{ Vector} = 5 \text{ units}$$

$$\theta = 30^\circ$$

$$V_y = V \sin \theta$$

$$V_y = 5 \sin 30$$

$$V_y = 2.5 \text{ units}$$

$$V_x = V \cos \theta$$

$$V_x = 5 \cos 30$$

$$V_x = 5 \times 0.866$$

$$V_x = 4.33 \text{ units}$$

$$16. A = 2i + 3j + 4k$$

$$B = i - 2j + 3k$$

$$A \cdot B = axbx + ayby + azbz$$

$$A \cdot B = (2 \times 1) + (3 \times -2) + (4 \times 3)$$

$$A \cdot B = 2 + (-6) + 12$$

$$A \cdot B = 8$$

$$A \cdot B = |A| |B| \cos \theta$$

$$|A| = \sqrt{ax^2 + ay^2 + az^2}$$

$$|A| = \sqrt{2^2 + 3^2 + 4^2}$$

$$|A| = \sqrt{4 + 9 + 16}$$

$$|A| = \sqrt{29}$$

$$|B|^2 = bx^2 + by^2 + bz^2$$

$$|B|^2 = 1^2 + (-2)^2 + 3^2$$

$$|B|^2 = 1 + 4 + 9$$

$$|B| = \sqrt{14}$$

$$A \cdot B = |A| |B| \cos \theta$$

$$8 = \sqrt{29} \times \sqrt{14} \cos \theta$$

$$\cos \theta = \frac{8}{\sqrt{29} \times \sqrt{14}}$$

$$\cos \theta = 0.397$$

$$\theta = \cos^{-1}(0.397)$$

$$\theta = 66.6^\circ$$

$$17. a \cdot b = |a| |b| \cos \theta \text{ and}$$

$$a \times b = |a| |b| \sin \theta \text{ are}$$

correct

$$18. A = 2i + 3j + 0k$$

$$B = 3i + 5j + 0k$$

$$C = 4i - 6j$$

$$A \times B = (aybz - azby)i +$$

$$(azbx - axbz)j +$$

$$(axby - aybx)k$$

Because a_z and b_z are zero, the formula become

$$A \times B = (axby - aybx)k$$

$$A \times B = (2 \times 5 - 3 \times 3)k$$

$$A \times B = (10 - 9)k$$

$$A \times B = 1k$$

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Answer =

$$(a \times b) \times c = 6i + 4j$$

19.



$$F_{1x} = 100 \cos 50^\circ = 64.3$$

$$F_{1y} = 100 \sin 50^\circ = 76.6$$

$$F_{2x} = -100 \cos 10^\circ = -98.5$$

$$F_{2y} = 100 \sin 10^\circ = 17.37$$

$$\Sigma F_x = F_{1x} + F_{2x}$$

$$\Sigma F_x = 64.3 + (-98.5)$$

$$F_x = -34.2$$

$$\Sigma F_y = F_{1y} + F_{2y}$$

$$F_y = 76.6 + 17.37$$

$$F_y = 93.97$$

$$/F/ = \sqrt{F_x^2 + F_y^2}$$

$$/F/ = \sqrt{(-34.2)^2 + (93.97)^2}$$

$$/F/ = 100N$$

Direction α

$$\tan \alpha = \frac{F_y}{F_x}$$

$$\tan \alpha = \frac{93.97}{-34.2}$$

$$\tan \alpha = -2.75$$

$$\alpha = -70^\circ$$

$$\alpha = 180 - 70$$

$$\alpha = 110^\circ$$

20. $R = 8i - 12j$

magnitude $/R/$

$$/R/ = \sqrt{8^2 + (-12)^2}$$

$$/R/ = \sqrt{8^2 + 12^2}$$

$$/R/ = 14.42$$

$$\text{Angle } \theta = \tan^{-1} \frac{y}{x}$$

$$\theta = \tan^{-1} \frac{-12}{8}$$

$$\tan \theta = -1.5$$

$$\theta = \tan^{-1}(-1.5)$$

$$\theta = -56.3^\circ$$

21. Frequency f , mass per unit

Length m ; tension T and its length L

$$f \propto mTL$$

$$f = kmTL$$

$$F = km^x T^y L^z$$

Dimensionally

$$T^{-1} = K(ML^{-1})^x (MLT^{-2})^y L^z$$

N.B.: Dimension of Tension =

$$\text{Force} = mxa = MLT^{-2}$$

$$T^{-1} = KM^x L^{-x} M^y L^y T^{-2y} L^z$$

$$T^{-1} = KM^{x+y} L^{-x+y+z} T^{-2y}$$

for

$$T: -1 = -2y$$

$$y = \frac{1}{2}$$

$$M: 0 = x + y$$

$$0 = x + \frac{1}{2}$$

$$x = -\frac{1}{2}$$

$$L: 0 = -x + y + z$$

$$0 = -(-\frac{1}{2}) + \frac{1}{2} + z$$

$$0 = \frac{1}{2} + \frac{1}{2} + z$$

$$0 = 1 + z$$

$$z = -1$$

$$f = km^{-1/2} T^{1/2} L^{-1}$$

$$f = k L \sqrt{\frac{T}{m}}$$

22. $A = 6i + 3j - k$

$$B = 4i - 5j + 8k$$

$$2A = 2(6i + 3j - k)$$

$$= 12i + 6j - 2k$$

$$2A - B = (12i + 6j - 2k) -$$

$$(4i - 5j + 8k)$$

$$2A - B = 12i + 6j - 2k - 4i + 5j - 8k$$

$$2A - B = (12 - 4)i + (6 + 5)j + (-2 - 8)k$$

$$= 8i + 11j - 10k$$

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$$2A - B = 8i + 11j - 10k$$

$$\text{magnitude} = |2A - B|$$

$$|2A - B| = \sqrt{8^2 + 11^2 + 10^2}$$

$$= \sqrt{285}$$

$$= 16.9$$

Question 23, 24, 25 and 26

should be solved by students as assignments. Thanks.

23.

24.

25.

26.

27. $p = 2t^3i + (t^3 - 5t^2)j$

speed is the magnitude of the time rate of change of position

i.e.

(a) $\text{Speed} = \left| \frac{dp}{dt} \right|$

$$\frac{dp}{dt} = 6t^2i + (3t^2 - 10t)j$$

$$\text{at } t = 3s$$

$$\frac{dp}{dt} = 54i + (-3)j$$

$$\text{speed} = \frac{dx}{dt} = 54^2 + (-3)^2$$

$$\text{speed} = 54 \text{ m/s}$$

(b) Velocity, $V = \frac{dx}{dt}$

$$V = 54i - 3j \text{ m/s}$$

(c) Acceleration, a

$$a = \frac{dv}{dt}$$

$$a = \frac{d}{dt} (6ti + (3t^2 - 10t)j)$$

$$a = 12ti + (6t - 10)j$$

$$\text{at } t = 3s$$

$$a = 36i + 8j \text{ m/s}^2$$

28. $x = 3.0 + 0.2t^4 \text{ (m)}$

(a) Instantaneous velocity at

$$t = 3s$$

$$V = \frac{dx}{dt}$$

$$V = d(3 + 0.2t^4)$$

$$V = 0 + 4 \times 0.2t^3$$

$$V = 0.8t^3$$

$$V = 0.8 \times 3^3$$

$$V = 0.8 \times 27$$

$$V = 21.6 \text{ m/s}$$

(b) Average vel = $\frac{\Delta x}{\Delta t}$

$$V = \frac{x_2 - x_1}{t_2 - t_1}$$

$$\text{At } t = 2s$$

$$x = 3 + 0.2(2)^4 = 6.2$$

$$\text{At } t = 4s$$

$$x = 3 + 0.2(4)^4 = 54.2$$

$$V = \frac{x_2 - x_1}{t_2 - t_1}$$

$$V = \frac{54.2 - 6.2}{2}$$

$$V = 24 \text{ m/s}$$

29. $U = 0$

$$V = 100 \text{ km/hr} = \frac{100 \times 1000}{3600}$$

$$v = 27.78 \text{ m/s}$$

$$t = 10s$$

(a) average acceleration

$$a = \frac{v - u}{t}$$

$$a = \frac{27.78 - 0}{10}$$

$$a = 2.8 \text{ m/s}^2$$

(b) $S = V_0t + \frac{1}{2}at^2$

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$$100 = 0 + \frac{1}{2} \times 2.8 \times t^2$$

$$t^2 = 71.4$$

$$t = 8.5 \text{ second}$$

$$30. \quad x = 20 + 15t + 15t^2$$

$$t = 4s$$

$$(a) \quad V = \frac{dx}{dt}$$

$$V = \frac{d(20 + 15t + 15t^2)}{dt}$$

$$V = 0 + 15t^0 + 2 \times 15t$$

$$V = 15 + 30t$$

$$V = 15 + 30(4)$$

$$V = 135 \text{ m/s}$$

(b) Average velocity V during the first four seconds

$$V = \frac{\Delta x}{\Delta t}$$

$$V = \frac{x_2 - x_1}{t_2 - t_1}$$

At x_1 , time $t = 0$

$$x = 20 + 15t + 15t^2$$

$$x = 20 + 15(2) + 15(0)^2$$

$$x_1 = 20 \text{ m}$$

At x_2 , time $t = 4s$

$$x_2 = 20 + 15(4) + 15(4)^2$$

$$x_2 = 20 + 60 + 240$$

$$x_2 = 320 \text{ m}$$

$$v = \frac{320 - 20}{4 - 0}$$

$$V = \frac{300}{4} = 75 \text{ m/s}$$

$$31. \quad V_0 = 50 \text{ m/s}$$

$$a = -g = 9.8 \text{ m/s}^2$$

(as) Height to which it rises $V_y = 0$

$$V_y^2 = V_{0y}^2 - 2gH$$

$$0 = 50^2 - 2 \times 9.8H$$

$$2 \times 9.8H = (50)^2$$

$$19.6H = 2500$$

$$H = \frac{2500}{19.6}$$

$$H = 127.6 \text{ m}$$

(b) At max. height $V_y = 0$

$$V_y = V_{0y} - gt$$

$$V_y = V_{0y} - gt$$

$$0 = 50 - 9.8t$$

$$9.8t = 50$$

$$t = \frac{50}{9.8} = 5.1 \text{ s}$$

$$9.8$$

time to reach max. height = 5.1 s

(c) $V_y = V_{0y} + at$

$$V_y = V_{0y} - gt$$

with $t = 3 \text{ sec}$, $V_{y0} = 50 \text{ m/s}$

$$a = -g$$

$$V_y = 50 - 9.8 \times 3$$

$$V_y = 50 - 29.4$$

$$V_y = 20.6 \text{ m/s}$$

(d) The distance covered in the third second is

$$y = V_{0y}t + \frac{1}{2}at^2$$

$$y = V_{0y}t + \frac{1}{2}at^2$$

for $t = 3 \text{ s}$, $g = 10 \text{ m/s}^2$

$$y = 50 \times 3 - \frac{1}{2} \times 10 \times (3)^2$$

$$y = 105 \text{ m}$$

for $t = 2 \text{ s}$

$$y = 50 \times 2 - \frac{1}{2} \times 10 \times (2)^2$$

$$y = 80 \text{ m}$$

the distance covered in the third

second = $105 - 80 = 25 \text{ m}$

(e) $V_y^2 = V_{0y}^2 + 2ay$, $y=0$

$$V_y^2 = (50)^2 + 2 \times -10 \times 0$$

$$V_y^2 = 2500$$

$$V_y = 50 \text{ m/s}$$

$$V_y = 50 \text{ m/s}$$

32. The angle must be inclined to the horizontal. Hence, since the

angle is 30° to the vertical,
subtract 30° from 90° . so,
 $\theta = 60^\circ$

$$V = 10 \text{ m/s}$$

$$(a) \text{ Height } H = \frac{V_0^2 \sin^2 \theta}{2g}$$

$$H = \frac{(10)^2 \sin^2 (60)}{2 \times 10}$$

$$H = \frac{100 \times 0.75}{20}$$

$$H = 3.75 \text{ m}$$

(b) time taken to reach max.
height t

$$t = \frac{V_0 \sin \theta}{g}$$

$$t = \frac{10 \sin 60}{10}$$

$$t = 0.866 \text{ s}$$

$$t = 0.9 \text{ s}$$

$$(c) \text{ Range, } R = \frac{V_0^2 \sin 2\theta}{g}$$

$$R = \frac{(10)^2 \sin 2(60)}{10}$$

$$R = 8.7 \text{ m}$$

33. omitted

34. (a) At maximum height

$$V_y = \text{zero}$$

$$\text{apply } V_y = V_{oy} + at$$

$$a = -g$$

$$V_y = V_{oy} - gt$$

$$V_{oy} = 8.7$$

$$V_{ox} = 5$$

$$0 = 8.7 - 10t$$

$$10t = 8.7$$

$$t = \frac{8.7}{10}$$

$$10$$

$$t = 0.9 \text{ s}$$

(b) The height to which the

ball rises

$$V_y^2 = V_{oy}^2 - 2gH$$

$$0 = (8.7)^2 - 2 \times 10 \times H$$

$$20H = (8.7)^2$$

$$H = (8.7)^2 / 20$$

$$H = 3.8 \text{ m}$$

(c) Range = horizontal
distance travelled.

$$R = V_{ox} \times 2t$$

$$R = 5 \times 2 \times 0.9$$

$$R = 9 \text{ m}$$

$$35. (a) V_m - V_r = V_m'$$

$$\sin \theta = \frac{V_r}{V_m} = \frac{1.5}{2.5}$$

$$V_m = 2.5$$

$$\theta = 36.9^\circ \text{ up stream}$$

(b) Required time

$$V = d/t$$

$$t = \frac{d}{V} = \frac{1.0 \text{ km}}{V}$$

$$V = V_m'$$

$$(V_m')^2 + (1.5)^2 = (2.5)^2$$

$$(V_m')^2 = (2.5)^2 - (1.5)^2$$

$$V_m' = 2 \text{ km/hr}$$

$$t = \frac{1 \text{ km}}{2 \text{ km/hr}} = 30 \text{ min}$$

$$2 \text{ km/hr}$$

36. Equal to gradient of a velocity -
time graph

$$37. x = 6t - 4t^2 + t^3$$

$$x(t) = 6t - 4t^2 + t^3$$

$$x(3) = (6(3) - 4(3)^2 + 3^3) \text{ m}$$

$$= (18 - 36 + 27) \text{ m} = 9 \text{ m}$$

$$x(5) = (6(5) - 4(5)^2 + 5^3) \text{ m}$$

$$= 55 \text{ m}$$

$$\text{Displacement} = x(5) - x(3)$$

$$= 55 - 9 = 46 \text{ m}$$

Average velocity

$$V = \frac{x_5 - x_3}{5 - 3}$$

$$5 - 3$$

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$$V = \frac{55 - 9}{2}$$

$$V = 23 \text{ m/s}$$

38. Average velocity, V_{av}

$$V = \frac{r_2 - r_1}{t_2 - t_1}$$

$$V = \frac{(7i - 6j - 3k) - (5i - 6j - 2k)}{10}$$

$$V = \frac{2i - 5k}{10}$$

$$V = 0.2i - 0.5k$$

$$|V| = \sqrt{(0.2)^2 + (0.5)^2}$$

$$|V| = 0.539 \text{ m/s}$$

39. Displacement $x = x_2 - x_1$

$$x = 4 - 12 = -8 \text{ m}$$

Average velocity

$$V = \frac{x_2 - x_1}{t_2 - t_1}$$

$$V = \frac{4 - 2}{3 - 1} = -4 \text{ m/s}$$

40. $V_0 = 50 \text{ m/s}$

$$V = 20 \text{ m/s}$$

$$a = -10 \text{ m/s}^2$$

distance traveled = ?

$$V^2 = V_0^2 + 2as$$

$$20^2 = 50^2 - 2 \times 10 \times s$$

$$20^2 = 2500 - 20s$$

$$400 - 2500 = -20s$$

$$-2100 = -20s$$

$$S = \frac{2100}{20}$$

$$S = 105 \text{ m}$$

41. $V_0 = 15 \text{ m/s}$ $V = 20 \text{ m/s}$

$$a = 2 \text{ m/s}^2$$

$$V = V_0 + at$$

$$t = \frac{V - V_0}{a}$$

$$t = \frac{20 - 15}{2}$$

$$t = 2.5 \text{ s}$$

Using

$$x = V_0 t + \frac{1}{2} at^2$$

$$x = 15 \times 2.5 + \frac{1}{2} \times 2 \times (2.5)^2$$

$$x = 43.75 \text{ m}$$

42. $V_0 = 0$, $a = 6.8 \text{ m/s}^2$

$$H = 1.7 \text{ m}$$

$$H = V_0 t + \frac{1}{2} at^2$$

$$1.7 = 0 + \frac{1}{2} \times 6.8 \times t^2$$

$$t = 0.5$$

$$t = 0.7 \text{ s}$$

43. Answer: acceleration

44. Assignment for students

45. the x and y components of the initial velocity are $V_{0x} = 20 \text{ m/s}$,

$$V_{0y} = 0$$

For the vertical motion,

$$y = V_{0y} t + \frac{1}{2} gt^2$$

$$45 = 0 + \frac{1}{2} \times 9.8 t^2$$

$$t = 3.03 \text{ s}$$

For horizontal motion

$$a_x = 0$$

$$x = V_{0x} t + \frac{1}{2} a_x t^2$$

$$x = V_{0x} t$$

$$x = R = 20 \times 3.03$$

$$R = 60.58 \text{ m}$$

$$R = 60.6 \text{ m}$$

46. For horizontal motion

$$V_x = V_{0x} + a_x t$$

$$V_x = 20 + 0 \times t$$

$$V_x = 20 \text{ m/s}$$

For vertical motion,

$$V_y = V_{0y} + a_y t$$

$$V_y = (0 + 9.8 \times 3.03) \text{ m/s}$$

$$V_y = 29.72 \text{ m/s}$$

Therefore, using Pythagoras

theorem we obtain the

magnitude of the velocity.

$$V = \sqrt{20^2 + 29.72^2} = 35.82 \text{ m/s}$$

$$\tan \theta = \frac{V_y}{V_x} = \frac{29.72}{20} = 1.486$$

$$V_x = 20$$

$$\theta = 56.06^\circ$$

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47. $V_0 = 50 \text{ m/s}$
 $\theta = 30^\circ$ $g = 10 \text{ m/s}^2$
 (a) Time of flight $T = \frac{2V_0 \sin \theta}{g}$

$$T = \frac{2 \times 50 \sin 30}{10}$$

$$T = 5 \text{ seconds}$$
 (b) Maximum height, H

$$H = \frac{V_0^2 \sin^2 \theta}{2g}$$

$$H = \frac{(50)^2 \sin^2(30)}{2 \times 10}$$

$$H = 31.25 \text{ m}$$
 (c) Range = $\frac{V_0^2 \sin 2\theta}{g}$

$$R = \frac{(50)^2 \sin 2(30)}{10}$$

$$R = 217 \text{ m}$$
48. $V = 9.25 \text{ m/s}$
49. $V_0 = 0$, $t = 40 \text{ s}$, $x = 1200 \text{ m}$
 Using,

$$x = \frac{V_0 + V}{2} \times t$$

$$1200 = \frac{0 + V}{2} \times 40$$

$$V = 1200 = 60 \text{ m/s}$$

$$20$$
50. Answer: time
 $t = 2.5 \text{ s}$
 height $H = 30.4 \text{ m}$
51. At maximum height $V = 0$
 $g = 9.8 \text{ m/s}^2$
 $V^2 = V_0^2 - 2gH$
 $0 = V_0^2 - 2 \times 9.8 \times 50$
 $V_0^2 = 980$
 $V_0 = 31.3 \text{ m/s}$
52. $R = \frac{V_0^2 \sin 2\theta}{g}$
- $R = 5 \text{ km}$
 $R = 5000 \text{ m}$
 $5000 = \frac{V_0^2 \sin 2(30)}{9.8}$
 $5000 = \frac{V_0^2 \sin 60}{9.8}$
 $V_0^2 = 5000 \times 9.8$
 $\sin 60$
 $V_0 = \sqrt{56580}$
 $V_0 = 237.86 \text{ m/s}$
 $H_{\max} = \frac{V_0^2 \sin^2 \theta}{2g}$
 $H_{\max} = \frac{56580 \times \sin^2(30)}{2 \times 9.8}$
 $H_{\max} = 721.7 \text{ m}$
53. $H = \frac{V_0^2 \sin 2\theta}{2g} = \frac{(20)^2 \sin^2(40)}{2 \times 9.8}$
 $H = 8.43 \text{ m}$
Time of flight
 $T = \frac{2V_0 \sin \theta}{g}$
 $T = \frac{2 \times 20 \times \sin 40}{9.8}$
 $T = 2.62 \text{ s}$
54. $V^2 = 12.5^2 + 20.0^2$
 $V^2 = 156.25 + 400$
 $V = 23.58 \text{ m/s}$
 $\tan \theta = \frac{V_y}{V_x} = \frac{20.0}{12.5} = 1.6$
 $\theta = \tan^{-1}(1.6) = 58^\circ$
 (b) Total time of flight
 $T = \frac{2V_0 \sin \theta}{g}$
 $T = \frac{2 \times 23.58 \times \sin 58}{9.8}$
 $T = 4.08 \text{ s}$

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Horizontal range (R)

$$R = \frac{(23.58)^2 \sin(2 \times 58)}{9.8}$$

$$9.8$$

$$R = 51.0\text{m}$$

55. Solution omitted

56. Horizontal component of initial velocity, $V_{ox} = 15\text{m/s}$. Vertical component of initial velocity,

$$V_{oy} = 0$$

$$a_x = 0, a_y = 9.8\text{m/s}^2$$

$$y = V_{oy}t + \frac{1}{2}a_yt^2$$

$$75 = 0 + \frac{1}{2} \times 9.8 \times t^2$$

$$t^2 = 3.91\text{s}$$

57. $V_o = 30\text{m/s}$, $V = 0$

$$a = -2\text{m/s}^2$$

$$V^2 = V_o^2 + 2a_x$$

$$0 = 30^2 + 2 \times (-2)x$$

$$0 = 900 + (-4x)$$

$$x = \frac{900}{4} = 225\text{m}$$

$$4$$

58. $V_o = 20\text{m/s}$, $V = 5\text{m/s}$

$$t = 10\text{s}$$

$$a = \frac{V - V_o}{t} = \frac{5 - 20}{10} = -1.5\text{m/s}^2$$

x = distance covered in 4s-

distance covered in 3s

$$x = (V_o t_4 + \frac{1}{2} a t_4^2) - (V_o t_3 + \frac{1}{2} a t_3^2)$$

Re-arranging

$$x = V_o (t_4 - t_3) - \frac{1}{2} a (t_4^2 - t_3^2)$$

$$x = 20 \times (4 - 3) - \frac{1}{2} \times (-1.5)(16 - 9) \text{ m}$$

$$x = 20 - 5.25 \text{ m} = 14.75\text{m}$$

59. $V_o = 20\text{m/s}$

At maximum height, $V = 0$

$$g = -10\text{m/s}^2$$

$$V_y^2 - V_o^2 = -2gH$$

$$0 = (20)^2 - 2 \times 10H$$

$$H = \frac{(20)^2}{20} = 20\text{m}$$

$$20$$

60. $d = 1200\text{m}$

$$V_o = 0$$

$$t = 1\text{min} = 60\text{s}$$

Average speed V

$$d = \frac{V + V_o}{2} \times t$$

$$1200 = \frac{V + 0}{2} \times 60$$

$$1200 \times 2 = 60V$$

$$V = \frac{1200 \times 2}{60} = 40\text{m/s}$$

61. $a = 2.6\text{m/s}^2$

$$d = 70\text{m}$$

$$t = 5.4\text{s}$$

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

$$70 = U \times 5.4 + \frac{1}{2} \times 2.6 \times (5.4)^2$$

$$70 = 5.4U + 37.91$$

$$5.4U = 70 - 37.91$$

$$U = \frac{32.1}{5.4} = 5.94\text{m/s}$$

$$5.4$$

Final velocity, V

$$V = U + at$$

$$V = 5.94 + 2.6 \times 5.4$$

$$V = 19.98\text{m/s}^2$$

62. $W = 12000\text{N}$

$$V_o = 0, V = 90\text{km/hr} = 25\text{m/s}$$

$$t = 80\text{seconds}$$

$$W = mg$$

$$m = \frac{W}{g} = \frac{12000}{10} = 1200\text{kg}$$

to find acceleration, a

$$V = V_o + at$$

$$25 = 0 + a \times 80$$

$$a = \frac{25}{80} = 0.31\text{m/s}^2$$

hence, $F = ma$

$$F = 1200 \times 0.31 = 372\text{N}$$

63. $F = ma$

$F_x = m_{ax}$ and F_y and M_{ay}

consider motion along the x-axis

$V_x = V_{ox} + a_x t$

$V_x = 10 \text{ m/s}$ V_{ox}

$10 = 5 + a_x \times 10$

$a_x = \frac{5}{10} = 0.5 \text{ m/s}^2$

10

and $F_x = M a_x = 5 \times 0.5 = 2.5 \text{ N}$

Similarly for motion along the y-axis

$V_y = V_{oy} + a_y t$

$15 = 5 + a_y \times 10$

$a_y = 1.0 \text{ m/s}^2$

$F_y = m a_y$

$F_y = 5 \times 1.0 = 5 \text{ N}$

Force $F = \sqrt{F_x^2 + F_y^2}$

$F = \sqrt{2.5^2 + 5^2} = 5.6 \text{ N}$

$F = 5.6 \text{ N}$

64. $V_x = 0$ (stone come to rest),

$V_{ox} = 5 \text{ m/s}$ and distance = 12cm

$d = 0.12 \text{ m}$

$V_x^2 = V_{ox}^2 + 2ax$

$0 = (5)^2 + 2 \times a \times (0.12)$

$0 = 25 + 0.24a$

$a = -104.2 \text{ m/s}^2$

Resisting Force, $F = ma$

$F = 0.6 \times -104.2$

$F = -62.5 \text{ N}$

65. $M_1 = 7 \text{ kg}$, $M_2 = 5 \text{ kg}$

When the blocks are released, they will exert equal but opposite forces on each other.

F_1 and $-F_2$

$m_1 a_1 = -m_2 a_2$

$a_2 = \frac{14}{5} = -2.8 \text{ m/s}^2$

-5

that is, the 5kg block has an

acceleration of 2.8 m/s^2 towards the 7kg block.

66. T denote tension

For m_1 , the net force is

$T_1 = m_1 a_x \dots \dots \dots (i)$

For m_2 , the net force

$m_2 g - T_2 = m_2 a_y \dots \dots \dots (ii)$

$T_1 = T_2$ (inextensible string)

$a_x = a_y$

Hence equation (i) and (iii) becomes

$T = m_1 a$ and

$M_2 g - T = m_2 a$

$m_2 g - m_1 a = m_2 a$

$m_2 g = a (m_1 + m_2)$

$a = \frac{m_2 g}{m_1 + m_2}$

$a = \frac{5 \times 10}{5 + 5} = 5 \text{ m/s}^2$

(5 + 5)

Recall $T = m_1 a$

$T = 5 \times 5 = 25 \text{ N}$

67. Solution omitted

Answer

Tension = 51.6N

68. $M_1 = 5 \text{ kg}$, $M_2 = 8 \text{ kg}$

$\theta_1 = 40^\circ$ $\theta_2 = 30^\circ$

For $m_1 = m_1 g \sin 30 - T = m_1 a$

For $m_2: T - m_2 g \sin 40 = m_2 a$

Combining these two equations gives

$a = (m_1 \sin 30 - m_2 \sin 40)g$

$m_1 + m_2$

$a = \frac{(8 \times \sin 30 - 5 \times \sin 40) \times 10}{(8 + 5)}$

(8 + 5)

$a = 0.6 \text{ m/s}^2$

69. $M_1 = 9 \text{ kg}$ $M_2 = 6 \text{ kg}$

The heavier one (9kg) will move downward, hence

$$M_1 g - T = m, a \quad \dots\dots (i)$$

For M_2

$$T - M_2 g = M_2 a \quad \dots\dots (ii)$$

Combine equation (i) and (ii)

$$a = \frac{(M_1 - M_2)g}{(M_1 + M_2)}$$

$$a = \frac{(9 - 6) \times 10}{9 + 6}$$

$$a = 2 \text{ m/s}^2$$

To determine Tension T,

$$M_1 g - T = m, a$$

$$9 \times 10 - T = 9 \times 2$$

$$T = 72 \text{ N}$$

70. Net force $F = m a$

$$\therefore R - W = m a$$

$$R = m a + W$$

$$\text{Mass} = \frac{W}{g}$$

$$m = \frac{640}{10} = 64$$

(a) When the elevator is accelerating up at 2 m/s^2

then, $M = 64 \text{ kg}$

$$R - W = m a$$

$$R = m a + W$$

$$R = m a + m g$$

$$R = m (a + g)$$

$$R = 64 (2 + 10)$$

$$R = 768 \text{ N}$$

(b) A constant speed, acceleration

$$a = 0$$

$$R - W = 0$$

$$R = W$$

$$R = m g$$

$$R = 64 \times 10 = 640 \text{ N}$$

(c) The upward deceleration of 2 m/s^2 implies that

$$a = -2 \text{ m/s}^2$$

$$R = m (a + g)$$

$$R = 64 (-2 + 10)$$

$$R = 64 \times 8 = 512 \text{ N}$$

71. Solution Omitted

$$\text{Answer: } T_1 = 33 \text{ N}$$

$$T_2 = 44 \text{ N}$$

72. Answer: weight = 148 N

$$73. V = 20 \text{ km/hr} \quad \frac{20 \times 1000}{3600}$$

$$V = 5.56 \text{ m/s}$$

$$r = 8 \text{ m} \quad \mu = ?$$

$$F = m v^2 / r$$

$$\text{Frictional force } F_r = \mu m g$$

$$\text{Frictional Force} = \text{centripetal Force}$$

$$\mu m g = m v^2 / r$$

$$\mu g = \frac{v^2}{r}$$

$$\mu = \frac{v^2}{r g}$$

$$\mu = \frac{(5.6)^2}{8 \times 10} = 0.4$$

74. $F = 200 \text{ N}$

$$M = 50 \text{ kg}$$

$$\text{Frictional Force } F_K = 60 \text{ N}$$

$$\text{acceleration } a = ?$$

$$\text{Resultant Force } F_R = F - F_K$$

$$F_R = 200 - 60 = 140 \text{ N}$$

$$\text{From } F_R = m a$$

$$140 = 50 a$$

$$a = 140 / 50$$

$$a = 2.8 \text{ m/s}^2$$

75. $M = 1000 \text{ kg}, a = 2 \text{ m/s}^2$

$$\text{Resultant Force, } F_R = m a$$

$$F_R = 1000 \times 2 = 2000 \text{ N}$$

72

Let force, due to the engine be P_1
then

$$F_R = P - 1000 = ma$$

$$P = ma + 1000$$

$$P = (1000 \times 2 + 1000) = 3000\text{N}$$

76. Answer: $F = 4.175 \times 10^3 \text{N}$

77. omitted

78. $F_X = ma$

$$25 \cos 60 = 3.5ax$$

$$a = 3.57 \text{m/s}^2$$

79. $F_R = ma$

$$25 = 2 \times a$$

$$a = 12.5 \text{m/s}^2$$

$$V^2 = V_0^2 + 2ax$$

$$V^2 = 10^2 + 2 \times 12.5 \times 4$$

$$V^2 = 200$$

$$V = 14.1 \text{m/s}^2$$

80. $V_0 = 0$, $x = 72 \text{m}$, $t = 6\text{s}$,

$$x = V_0 t + \frac{1}{2} at^2$$

$$72 = 0 + \frac{1}{2} a \times (6)^2$$

$$72 = 18a$$

$$a = 4 \text{m/s}^2$$

$$F = ma$$

$$80 = m \times 4$$

$$m = \frac{80}{4} = 20 \text{kg}$$

$$4$$

81. Resultant force $F_R = ma$

$$5 - fk = 2 \times a$$

$$5 - N_k mg = 2 \times a$$

$$5 - 0.2 \times 2 \times 9.8 = 2 \times a$$

$$1.08 = 2a$$

$$a = 0.54 \text{m/s}^2$$

82. impulse = $m(V - V_0)$

$$\text{impulse} = 0.06(35 - (-25))$$

$$\text{impulse} = 0.06(35 + 25)$$

$$= 3.6 \text{Ns}$$

83. $m = 200\text{g} = 0.2\text{kg}$

$$V_0 = 0, V = 100 \text{cm/s} = 1 \text{m/s}$$

$$\text{impulse} = \text{change in momentum}$$

$$\text{impulse} = m(V - V_0)$$

$$\text{impulse} = 0.2(1 - 0)$$

$$\text{impulse} = 0.2 \text{kg m/s}$$

84. $m_1 = 0.5\text{kg}$, $U_1 = ?$

$$U_2 = 0, m_2 = 100\text{kg}$$

$$V_1 = V_2 = V = 0.4 \text{m/s}$$

$$M_1 U_1 + M_2 U_2 = M_1 V_1 + M_2 V_2$$

$$0.5 U_1 + 100 \times 0 = 0.5 \times 0.4 +$$

$$100 \times 0.4$$

$$0.5 U_1 + 0 = 40.2$$

$$U_1 = \frac{40.2}{0.5} = 80.4 \text{m/s}$$

$$0.5$$

85. $M_A U_A + M_B U_B = M_A V_A + M_B V_B$

$$2(15i + 30j) + 2(-10i + 5j) = 2(-$$

$$5i + 20j) + 2V_B$$

$$15i + 30j + (-10i + 5j) = 5i + 20j$$

$$+ V_B$$

$$(15 + (-10))i + (30 + 5)j = -5i +$$

$$20j + 2V_B$$

$$5i + 35j + -5i + 20j = V_B$$

$$(5i + 35j) - (5i + 20j) = V_B$$

$$5i + 35j + 5i - 20j = V_B$$

$$10i + 15j = V_B$$

$$V_B = 10i + 15j$$

86. $M_1 U_1 + M_2 U_2 = (M_1 + M_2)V$

$$0.002 \times 800 + 2 \times 0 =$$

$$(0.002 + 2)V$$

$$V = 0.799 \text{m/s}$$

87. $m = 2\text{kg}$

$$V_0 = 7 \text{m/s}, v = 3 \text{m/s}$$

$$t = 3\text{s}, F = ?$$

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

$$t$$

73

$$F = 2 \times \frac{(3-7)}{3}$$

$$F = 2 \times \frac{(-4)}{3} = -2.67N$$

$$88. m = 8000 + 40000$$

$$m = 48000kg$$

$$a = 1.2m/s^2$$

$$F = 48000 \times 1.2 =$$

$$F = 57600N$$

$$F = ma$$

$$57600 = 16000a$$

$$a = 3.6m/s^2$$

$$89. m_1 u_1 + m_2 u_2 = (m_1 + m_2) V$$

$$m_1 = 8kg \quad m_2 = 4kg$$

$$u_1 = 11m/s$$

$$u_2 = -7m/s \text{ (opposite)}$$

$$8 \times 11 + (4 \times -7) = (8+4)V$$

$$88 - 28 = 12V$$

$$V = 5m/s$$

$$90. \text{Work} = F \cdot r$$

$$\text{displacement } r = r_2 - r_1$$

$$r = (3i - 2j - k) - (-2i + 3j + k)$$

$$r = 3i - 2j - k + 2i - 3j - k$$

$$r = (3+2)i + ((-2)+(-3))j + ((-1)+(-1))k$$

$$r = 5i - 5j - 2k$$

$$W = F \cdot r$$

$$F = 2i - 3j - k$$

$$W = (2i - 3j - k) \cdot (5i - 5j - 2k)$$

$$\text{Recall } A \cdot B =$$

$$a_x b_x + a_y b_y + a_z b_z$$

$$W = (2 \times 5) + (-3 \times -5) + (-1 \times -2)$$

$$W = 10 + 15 + 2$$

$$W = 27Joules$$

$$91. x = 20cm = 0.2m$$

$$\text{force constant, } k = 1000N/m$$

$$\text{work} = \frac{1}{2} k x^2$$

$$= \frac{1}{2} \times 1000 \times (0.2)^2$$

$$W = 20Joules$$

$$92. F = 4i + 3j - 2k$$

$$V = 5i + 2j - 3k$$

$$\text{instantaneous power} = F \cdot V$$

$$P = (4i + 3j - 2k) \cdot (5i + 2j - 3k)$$

$$\text{Recall, } A \cdot B = a_x b_x + a_y b_y +$$

$$a_z b_z$$

$$P = (4 \times 5) + (3 \times 2) + (-2 \times -3)$$

$$P = 20 + 6 + 6 =$$

$$P = 32w.$$

$$93. \text{Work done} = \text{Final k.E} - \text{Initial}$$

$$\text{k.E}$$

$$w = \frac{1}{2} m v^2 - \frac{1}{2} m v_0^2$$

$$V_0 = 120km/hr = 3.4m/s$$

$$V = 90km/hr = 25m/s$$

$$w = \frac{1}{2} \times 1200 \times (25)^2 - \frac{1}{2} \times 1200 \times (3.4)^2$$

$$w = 375000 - 669336$$

$$w = -294336$$

$$w = -29.4 \times 10^4 \text{ Joules}$$

$$94. \Delta V = V - V_0$$

$$\Delta V = (4i - 6j - 4k) - (2i + 3j +$$

$$4k)$$

$$\Delta V = 2i + 3j - 8k$$

$$F = ma$$

$$F = m \frac{\Delta V}{\Delta t} = \frac{6 \times (2i + 3j - 8k)}{10}$$

$$\Delta t = 10$$

$$F = (1.2i + 1.6j - 4.8k)N$$

$$\text{Its magnitude, } |F| =$$

$$|F| = \sqrt{(1.2)^2 + (1.6)^2 + (-4.8)^2}$$

$$|F| = 5.3N$$

$$95. w = 300 \text{ rev/min} = \frac{300 \times 2\pi}{60}$$

$$w = 10\pi \text{ rad/s}$$

$$\text{Tension} = \text{Centripetal force}$$

$$T = \frac{mv^2}{R} = m(wR)^2$$

$$T = mw^2 R$$

$$T = 3(10\pi)^2 \times 1.2$$

$$T = 3553.979\text{N}$$

$$T = 3600\text{N} \text{ (2 s.f.)}$$

$$96. \quad T^2 = 2\pi \frac{L \cos \theta}{g}$$

$$T = 2 \times 3.142 \times \frac{\sqrt{16 \cos 60}}{10}$$

$$T = 5.62\text{s}$$

$$97. \quad h = 400\text{km} = 4 \times 10^5 \text{ m}$$

$$t = T = 85\text{min} = 5.1 \times 10^3 \text{ s}$$

The radius of the circular orbit is

$$r = R + h$$

$$r = (6.4 \times 10^6 + 4 \times 10^5) \text{ m}$$

$$r = 6.8 \times 10^6 \text{ m}$$

$$\text{Tangential speed } v = \frac{2\pi r}{T}$$

$$V = \frac{2\pi \times 6.8 \times 10^6 \text{ m}}{5.1 \times 10^3 \text{ s}}$$

$$V = 8.4 \times 10^3 \text{ s}$$

Then the centripetal acceleration

is

$$a_c = \frac{V^2}{r} = \frac{(8.4 \times 10^3)^2}{6.8 \times 10^6}$$

$$a_c = 10.4 \text{ m/s}^2$$

$$98. \quad w_0 = 0, w = 400 \text{ rpm} = \frac{400 \times 2\pi}{60 \text{ rad/s}}$$

$$w = 41.8 \text{ rad/s}$$

$$t = 2.50 \text{ s}$$

$$\alpha = \frac{w - w_0}{t} = \frac{(41.8 - 0) \text{ rad/s}}{2.5 \text{ s}}$$

$$\alpha = 16.72 \text{ rad/s}^2$$

$$99. \quad f = 300 \text{ rev/min} = \frac{300 \times 2\pi \text{ rad}}{60 \text{ s}}$$

$$5 \text{ rad/s}$$

$$100. \quad V = wr$$

$$V = 31.42 \times 0.15$$

$$V = 4.713 \text{ m/s}$$

$$101. \quad W = \frac{1}{2} mv^2 - \frac{1}{2} mv_0^2$$

$$W = \frac{1}{2} m(v^2 - v_0^2)$$

$$W = \frac{1}{2} \times 1200 \times (25^2 - 0)$$

$$W = 3.75 \times 10^5 \text{ J}$$

$$P = \frac{\text{work}}{\text{Time}} = \frac{3.75 \times 10^5}{8}$$

$$P = 46.9 \times 10^3 \text{ W}$$

$$F = ? \quad m = 1300 \text{ kg}$$

$$V = 0, V = 20 \text{ m/s}$$

$$S = 80 \text{ m}$$

$$V_2 = V_0^2 + 2aS$$

$$20^2 = 0 + 2 \times a \times 80$$

$$a = \frac{400}{160} = 2.5 \text{ m/s}^2$$

$$160$$

$$F = ma$$

$$F = 1300 \times 2.5 =$$

$$F = 3250 \text{ N}$$

$$103. \quad W = P.E = mgh$$

$$P.E = 3 \times 9.8 \times 3.5$$

$$P.E = 102.9 \text{ J}$$

$$104. \quad \text{tensile strain} = \frac{\Delta L}{L_0} = \frac{5\% L}{L_0}$$

$$L_0 \quad L_0 = 0.05$$

Young modulus,

$$Y = \frac{\text{tensile stress}}{\text{tensile strain}} = \frac{2.5 \times 10^9}{0.05}$$

$$Y = 5 \times 10^{10} \text{ N/m}^2$$

$$105. \quad A_1 = 5.08 \text{ m}^2, A_2 = 0.13 \text{ m}^2$$

$$F_1 = ? \quad F_2 = 11.34 \text{ N}$$

$$P_1 = P_2$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_1 = 11.34$$

$$5.08 \quad 0.13$$

$$F_1 = 5.08 \times 11.34$$

$$0.13$$

$$F_1 = 443.1 \text{ N}$$

$$106. \quad \text{Volume, } V = 0.24 \text{ m}^3$$

$$t = 1 \text{ min} = 60 \text{ s}$$

$$\text{internal diameter} = 0.05 \text{ m}$$

$$\text{Area of pipe} = \pi r^2$$

75

$$A = \pi \times \frac{(0.05)^2}{2^2}$$

$$A = 2 \times 10^{-3} \text{ m}^2$$

Flow Rate $R = \frac{\text{volume}}{\text{Time}}$

$$R = \frac{0.24 \text{ m}^3}{60 \text{ s}}$$

$$R = 0.004 \text{ m}^3/\text{s}$$

$$R = AV$$

$$V = \frac{R}{A} = \frac{0.004}{2 \times 10^{-3}}$$

$$V = 2 \text{ m/s}$$

107 Pressure = ρgh

$$P = 1.05 \times 10^3 \times 9.8 \times 0.33$$

$$P = 3.4 \times 10^3 \text{ N/m}^2$$

108 Pressure at depth of

$$3 \text{ m} = 1000 \times 9.8 \times 3 = 2.94 \times 10^4 \text{ N/m}^2$$

Pressure = F/A

$$F = P \times A$$

$$F = 2.94 \times 10^4 \times 1.6$$

$$F = 4.7 \times 10^4 \text{ N}$$

109 Diameters

$$d_1 = 5 \text{ cm} = 0.05 \text{ m}$$

$$d_2 = 25 \text{ cm} = 0.25 \text{ m}$$

$$A = \pi r^2$$

$$r = \frac{d^2}{2} \quad A = \pi \frac{(d)^2}{2}$$

$$A_1 = \pi \frac{(0.05)^2}{2} = 1.96 \times 10^{-3} \text{ m}^2$$

$$A_2 = \pi \frac{(0.25)^2}{2} = 4.9 \times 10^{-2} \text{ m}^2$$

(a) pressure applied on fluid by small piston

$$p = 1.02 \times 10^5 \text{ N/m}^2$$

(b) Force on large piston

$$F = P \times A$$

$$F = 1.02 \times 10^5 \times 4.91 \times 10^{-2}$$

$$F = 5000 \text{ N}$$

110 Diameter, $d = 10 \text{ cm}$

$$d = 0.1 \text{ m}$$

$$A = \pi \frac{(0.1)^2}{2^2}$$

$$A_1 = 7.9 \times 10^{-3} \text{ m}^2$$

$$V_1 = 3 \text{ cm/s} = 3 \times 10^{-2} \text{ m/s}$$

(a) Flow rate $R = AV$

$$R = 7.9 \times 10^{-3} \times 3 \times 10^{-2}$$

$$R = 2.36 \times 10^{-4} \text{ m}^3/\text{s}$$

(b) For a 1 cm diameter faucet

$$A = \pi \frac{(0.01)^2}{2^2}$$

$$A = 7.85 \times 10^{-4} \text{ m}^2$$

$$R = AV$$

$$V = \frac{R}{A} = \frac{2.36 \times 10^{-4}}{7.8 \times 10^{-3}}$$

$$V = 3 \text{ m/s}$$

111 $V_1 = 1.5 \text{ m/s}$

$$A_1 = \pi \frac{(0.3)^2}{2^2} = 7.854 \times 10^{-2} \text{ m}^2$$

$$R_1 = R_2$$

$$A_1 V_1 = A_2 V_2$$

$$V_2 < A_1 V_1$$

$$V_2 = \frac{7.845 \times 10^{-2} \times 1.5}{7.845 \times 10^{-2}}$$

$$V_2 = 1.35 \times 10^3 \text{ m/s}$$

112 $A_1 = \pi \frac{(0.15)^2}{2^2} = 1.8 \times 10^{-2} \text{ m}^2$

$$V_1 = 2 \text{ m/s}$$

$$A_2 = \pi \frac{(0.6)^2}{2^2} = 2.83 \times 10^{-3} \text{ m}^2$$

$$= A_1 T_1$$

$$R = 1.8 \times 10^{-2} \times 2$$

$$R = 3.5 \times 10^{-2} \text{ m}^3/\text{s}$$

(b) $A_1 V_1 = A_2 V_2$

$$V_2 = A_1 V_1 / A_2$$

$$V_2 = \frac{3.5 \times 10^{-2} \times 2}{2.83 \times 10^{-3}}$$

$$V_2 = 12.5 \text{ m/s}$$

113 $P_1 - P_2 = 1 \times 10^5 \text{ N/m}^2$

$$V = 1.4 \text{ m}^3$$

$$W = (P_1 - P_2) V$$

$$W = 1 \times 10^5 \times 1.4$$

$$W = 1.4 \times 10^5 \text{ J}$$

N.B: work is independent of the pipe's diameter.

114 $P_1 = 2 \times 10^5 \text{ Pa}$ $V_1 = 1 \text{ m/s}$

$$V_2 = 10 \text{ m/s}$$

Bernoulli:

$$P_1 - P_2 = \frac{1}{2} \rho (V_2^2 - V_1^2) + \rho g (y_2 - y_1)$$

Since the pipe is horizontal,

$$y_2 - y_1 = 0$$

$$P_1 - P_2 = \frac{1}{2} \rho (V_2^2 - V_1^2)$$

Density of water = 1000 kg/m^3

$$P_1 - P_2 = \frac{1}{2} \times 1000 (10^2 - 1^2)$$

$$P_1 - P_2 = 4.95 \times 10^4 \text{ Pa}$$

$$P_2 = P_1 - 4.95 \times 10^4$$

$$= 2 \times 10^5 - 4.95 \times 10^4$$

$$= 1.51 \times 10^5 \text{ Pa}$$

115 $P_1 + \frac{1}{2} \rho V_1^2 = P_2 + \frac{1}{2} \rho V_2^2$

Pressure drop, $P_1 - P_2$

$$\begin{aligned} P_2 - P_1 &= \frac{1}{2} \rho (V_1^2 - V_2^2) \\ &= \frac{1}{2} \times 1000 (5.6)^2 - (2)^2 \\ &= 13.7 \times 10^3 \text{ pa} \end{aligned}$$

Hence, the pressure drop,

$$P_2 - P_1 = 13.7 \times 10^3 \text{ pa}$$

116 $A_1 V_1 = A_2 V_2$

$$4 \times 5 = 8 \times V_2$$

$$V_2 = 2.5 \text{ m/s}$$

Using the Bernoulli's equation

$$P_1 + \frac{1}{2} \rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g h_2$$

$$P_2 = P_1 + \frac{1}{2} \rho (V_1^2 - V_2^2) + \rho g (h_1 - h_2)$$

$$P_2 = 1.5 \times 10^5 + \frac{1}{2} \times 1000 (5^2 - 2.5^2) +$$

$$1000 \times 9.8 \times 10$$

$$P_2 = 257375 \text{ N/m}^2$$

$$P_2 = 2.6 \times 10^5 \text{ N/m}^2 \text{ or pa}$$