SP015
Physics 1
Semester I
Session 2023/2024
2 hours

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PRE PSPM 1

DO NOT OPEN THIS QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO.

INSTRUCTIONS TO CANDIDATE:

The question paper consists of **8 questions**.

Answer **all** questions.

The use of electronic calculator is permitted.

*This question paper consists of **8** printed pages.*

LIST OF SELECTED CONSTANT VALUES
SENARAI NILAI PEMALAR TERPILIH

Speed of light in vacuum *Laju cahaya dalam vakum*	c	$= 3.00 \times 10^{8}$ m s^{-1}
Permeability of free space *Ketelapan ruang bebas*	μ_o	$= 4\pi \times 10^{-7}$ H m^{-1}
Permittivity of free space *Ketelusan ruang bebas*	ε_o	$= 8.85 \times 10^{-12}$ F m^{-1}
Electron charge magnitude *Magnitud cas elektron*	e	$= 1.60 \times 10^{-19}$ C
Planck constant *Pemalar Planck*	h	$= 6.63 \times 10^{-34}$ J s
Electron mass *Jisim elektron*	m_e	$= 9.11 \times 10^{-31}$ kg $= 5.49 \times 10^{-4}$ u
Neutron mass *Jisim neutron*	m_n	$= 1.674 \times 10^{-27}$ kg $= 1.008665$ u
Proton mass *Jisim proton*	m_p	$= 1.672 \times 10^{-27}$ kg $= 1.007277$ u
Hydrogen mass *Jisim hidrogen*	m_H	$= 1.673 \times 10^{-27}$ kg $= 1.007825$ u
Deuteron mass *Jisim deuteron*	m_d	$= 3.34 \times 10^{-27}$ kg $= 2.014102$ u
Molar gas constant *Pemalar gas molar*	R	$= 8.31$ J K^{-1} mol^{-1}
Avogadro constant *Pemalar Avogadro*	N_A	$= 6.02 \times 10^{23}$ mol^{-1}
Boltzmann constant *Pemalar Boltzmann*	k	$= 1.38 \times 10^{-23}$ J K^{-1}
Free-fall acceleration *Pecutan jatuh bebas*	g	$= 9.81$ m s^{-2}
Atomic mass unit *Unit jisim atom*	1 u	$= 1.66 \times 10^{-27}$kg $= 931.5 \frac{MeV}{c^2}$

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Electron volt *Elektron volt*	1 eV	$= 1.6 \times 10^{-19}$ J
Constant of proportionality for Coulomb's law *Pemalar hukum Coulomb*	$k = \frac{1}{4\pi\varepsilon_o}$	$= 9.0 \times 10^{9}$ N m^2 C^{-2}
Atmospheric pressure *Tekanan atmosfera*	1 atm	$= 1.013 \times 10^{5}$ Pa
Density of water *Ketumpatan air*	ρ_w	$= 1000$ kg m^{-3}

LIST OF SELECTED FORMULAE
SENARAI RUMUS TERPILIH

1. $v = u + at$
2. $s = ut + \frac{1}{2}at^2$
3. $v^2 = u^2 + 2as$
4. $s = \frac{1}{2}(u + v)t$
5. $p = mv$
6. $J = F\Delta t$
7. $J = \Delta p = mv - mu$
8. $f = \mu N$
9. $W = \vec{F} \cdot \vec{s} = Fs\cos\theta$
10. $K = \frac{1}{2}mv^2$
11. $U = mgh$
12. $U_s = \frac{1}{2}kx^2 = \frac{1}{2}Fx$
13. $W = \Delta K$
14. $P_{av} = \frac{\Delta W}{\Delta t}$
15. $P = \vec{F} \cdot \vec{v} = Fv\cos\theta$
16. $a_c = \frac{v^2}{r} = r\omega^2 = v\omega$
17. $F_c = \frac{mv^2}{r} = mr\omega^2 = mv\omega$
18. $s = r\theta$
19. $v = r\omega$
20. $a_t = r\alpha$
21. $\omega = \omega_o + \alpha t$
22. $\theta = \omega_o t + \frac{1}{2}\alpha t^2$
23. $\theta = \frac{1}{2}(\omega_o + \omega)t$
24. $\omega^2 = {\omega_o}^2 + 2\alpha\theta$
25. $\tau = rF\sin\theta$
26. $I = \sum mr^2$
27. $I_{\text{solid sphere}} = \frac{2}{5}MR^2$
28. $I_{\text{solid cylinder/disc}} = \frac{1}{2}MR^2$
29. $I_{\text{ring}} = MR^2$
30. $I_{\text{rod}} = \frac{1}{12}ML^2$
31. $\sum\tau = I\alpha$
32. $L = I\omega$
33. $y = A\sin\omega t$
34. $v = \omega A\cos\omega t = \pm\omega\sqrt{A^2 - y^2}$
35. $a = -\omega^2 A\sin\omega t = -\omega^2 y$
36. $K = \frac{1}{2}m\omega^2(A^2 - y^2)$
37. $U = \frac{1}{2}m\omega^2 y^2$
38. $E = \frac{1}{2}m\omega^2 A^2$
39. $\omega = \frac{2\pi}{T} = 2\pi f$
40. $T = 2\pi\sqrt{\frac{l}{g}}$
41. $T = 2\pi\sqrt{\frac{m}{k}}$
42. $k = \frac{2\pi}{\lambda}$

LIST OF SELECTED FORMULAE
SENARAI RUMUS TERPILIH

43. $v = f\lambda$

44. $y(x,t) = A\sin(\omega t \pm kx)$

45. $v_y = A\omega\cos(\omega t \pm kx)$

46. $y = 2A\ \cos kx \sin \omega t$

47. $f_n = \frac{nv}{2L}$

48. $f_n = \frac{n}{2L}\sqrt{\frac{T}{\mu}}$

49. $f_n = \frac{nv}{4L}$

50. $v = \sqrt{\frac{T}{\mu}}$

51. $\mu = \frac{m}{L}$

52. $f_a = \left(\frac{v \pm v_o}{v \mp v_s}\right) f$

53. $\sigma = \frac{F}{A}$

54. $\varepsilon = \frac{\Delta L}{L_o}$

55. $Y = \frac{\sigma}{\varepsilon}$

56. $U = \frac{1}{2}F\Delta L$

57. $\frac{U}{V} = \frac{1}{2}\sigma\varepsilon$

58. $\frac{Q}{t} = -kA\left(\frac{\Delta T}{L}\right)$

59. $\Delta L = \alpha L_o \Delta T$

60. $\Delta A = \beta A_o \Delta T$

61. $\Delta V = \gamma V_o \Delta T$

62. $\beta = 2\alpha$

63. $\gamma = 3\alpha$

64. $n = \frac{m}{M} = \frac{N}{N_A}$

65. $v_{rms} = \sqrt{\langle v^2 \rangle}$

66. $v_{rms} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}}$

67. $PV = \frac{1}{3}Nm{v_{rms}}^2$

68. $P = \frac{1}{3}\rho{v_{rms}}^2$

69. $K_{\text{tr}} = \frac{3}{2}\left(\frac{R}{N_A}\right)T = \frac{3}{2}kT$

70. $U = \frac{1}{2}fNkT = \frac{1}{2}fnRT$

71. $\Delta U = Q - W$

72. $W = nRT\ln\frac{V_f}{V_i} = nRT\ln\frac{P_i}{P_f}$

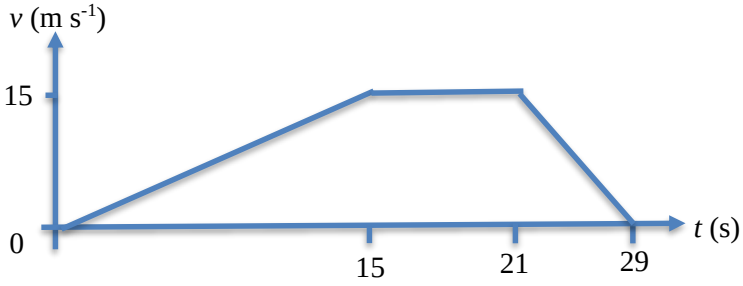
73. $W = \int PdV = P(V_f - V_i)$

74. $W = \int PdV = 0$

Answer ALL questions

1. The pressure P of a liquid with density ρ and moving with velocity v is given by $P = a - b\rho v^2$? What is the dimension of b? [3 marks]

2. (a) The graph velocity against time of the motion of the car is shown below.



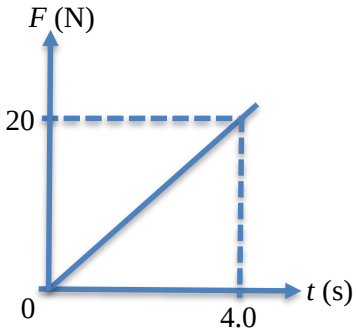
i) Find the average velocity of the car.

ii) Calculate the deceleration of the car.

iii) Determine the distance moved by the car within 25 s. [8 marks]

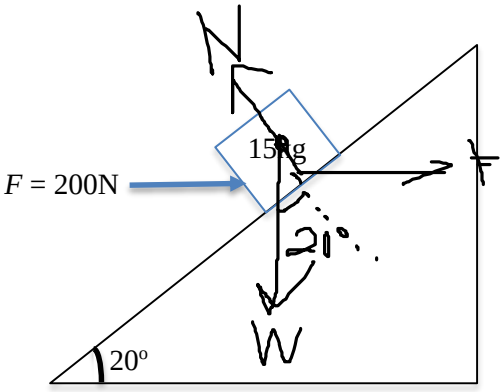
(b) A person throws a ball with velocity 10 m s^{-1} at angle of 30° above the horizontal. The distance between the initial velocity to the wall is 100 m. What is the vertical velocity of the ball just before it hits the wall? [3 marks]

3. (a) An object with mass 5.0 kg at rest is acted on by a force which increases uniformly from zero to 20 N in 4.0 s. Calculate the speed of the object at the end of the four seconds interval.



[2 marks]

(b)



A horizontal force of 200 N is required to cause a 15 kg block to slide up at 20° incline with an acceleration of 0.25 m s^{-2} as in Figure above.

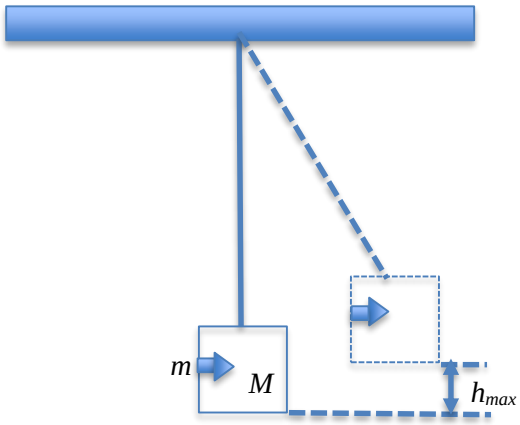
i) Sketch a free body diagram of the block

ii) Calculate the friction force.

iii) Find the coefficient of friction. [9 marks]

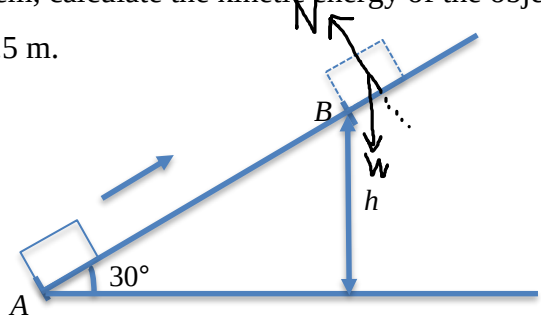
4. (a) In a block-bullet experiment, h_{max} = 5.00 cm, m = 5.00 g and M = 1.00 kg.

Find the common velocity after the bullet embedded into the block, v



[3 marks]

(b) An object of mass 2 kg moves up a rough inclined plane with an initial velocity of 14.14 m s^{-1}, which makes an angle 30° with the horizontal. The coefficient of kinetic friction between the object and the plane is 0.20. By using work-energy theorem, calculate the kinetic energy of the object at point B if the height h = 1.5 m.



[6 marks]

5. (a) A 0.4 kg object is swung in a vertical circular motion on a string 0.5 m long. If its speed is 4.0 m s^{-1} at the top of the circle, what is the tension of the string there?

[2 marks]

(b) A 1000 kg car is travelling at a constant speed of 15 m s^{-1} enters the circular curve of a flat road with radius 50 m. Show by calculation whether the car can go round the curve safely when the road is wet with the coefficient of static friction $\mu_s = 0.30$.

[3 marks]

6 (a) A particle vibrates and executes simple harmonic motion. The amplitude of the motion is 3.0 m and the frequency is 15 Hz.

(i) Calculate the velocity of the particle at time $t = 1.5$ s

(ii) Calculate the speed of the particle 1 m from one end

(iii) Sketch the graph of acceleration against time for this particle [9 marks]

(b) A vibrator is attached to one end of a slinky spring. A progressive wave propagates to the right with an amplitude of 5.0 cm along the spring when the vibrator vibrates with a frequency of 21 Hz. The distance between two consecutive compressions of the spring is 2.0 cm.

(i) Write the expression for the progressive wave

(ii) Sketch the displacement against distance graph at time $t = 0$ s [6 marks]

(c) A piano string, 1.5 m long, has a mass of 5 g.

(i) How much tension must the string be under for it to vibrate at a fundamental frequency of 100 Hz?

(ii) What is the frequency of the seventh overtone? [4 marks]

(d) A girl is running towards a wall with a ringing smartphone in her hand. The frequency of the ringing phone is 700 Hz and the speed of the girl is 1.5 m s^{-1}. If the ringing phone sends one pulse of sound, what will the frequency heard by the girl after the sound reflects off the wall? Given the speed of sound in air is 340 m s^{-1}.

[3 marks]

7. (a) Given a steel piano wire that is 1.60 m long with a diameter of 0.20 cm. Approximately what tension force would break it, considering that the stress of steel is 500×10^6 N m^{-2}. [2 marks]

(b) Two rooms, each a cube 4.0 m per side, share a 14 cm thick brick wall. Because of a total of 160 W lightbulbs in one room, the air is at 30°C, while in the other room, it is at 10°C. How many of the 160 W bulbs are needed to maintain the temperature difference across the wall? (Given *k* of wall = 0.84 W m^{-1} K^{-1}) [3 marks]

(c) The steel bed of a suspension bridge is 200 m long at 32°C. If the extremes of temperature to which it might be exposed are -30 °C to 42 °C, how much will it contract and expand? Given coefficient of linear expansion of steel is 12 x 10^{-6} K^{-1}. [3 marks]

8. (a) What is the root mean square speed of nitrogen molecules contained in a 5 m^3 volume at 2.9 atm, given that the total amount of nitrogen is 2100 mol? (Molar mass of N_2: 28 g/mol) [3 marks]

(b) An ideal gas expands at a constant total pressure of 3.0 atm from 320 ml to 550 ml. Heat then flows out of the gas at constant volume, and the pressure and temperature are allowed to drop until the temperature reaches its original value.

(i) Sketch the P-V graph for the process and label each process

(ii) Calculate the total work done in the process

(iii) Calculate the total heat flow during this process [8 marks]

END OF QUESTIONS PAPER