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 **13** 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. $W = \int PdV = 0$

No.	Answer Scheme	Marks
1.	L.H.S. $[\mathrm{P}] = [\rho][g][h]$ $[\mathrm{P}] = \frac{[\mathrm{m}]}{[\mathrm{V}]}[g][h]$ $[\mathrm{P}] = \mathrm{M}L^{-1}T^{-2}$ R.H.S. $[\rho] = \frac{[\mathrm{m}]}{[\mathrm{V}]}$ $[\rho] = \frac{\mathrm{M}}{L^3}$ $[\rho] = \mathrm{M}L^{-3}$ $[v^2] = (\mathrm{L}T^{-1})^2$ $[v^2] = L^2T^{-2}$ L.H.S. = R.H.S. $[\mathrm{P}] = [\, b\rho v^2]$ $[\mathrm{P}] = [\, b][\rho][v^2]$ $\mathrm{M}L^{-1}T^{-2} = [b](\mathrm{M}L^{-3})(L^2T^{-2})$ $\mathrm{M}L^{-1}T^{-2} = [b](\mathrm{M}L^{-1}T^{-2})$ $[b] = 1$ *b is dimensionless*	G1 G1 J1 **3**
2. (a)	**i)** $Average\ velocity = \frac{[Displacement]}{29}$ $Average\ velocity = \frac{[Area\ under\ the\ v-t\ graph]}{29}$ $Average\ velocity = \frac{\left[\left(\frac{1}{2}\right)(15)(15) + \left(\frac{1}{2}\right)(6+14)(15)\right]}{29}$ $Average\ velocity = \frac{[112.5 + 150]}{29}$ $Average\ velocity = 9.05\ \mathrm{m}s^{-1}$ **ii)** $a = \frac{0-15}{29-21}$ $a = -1.875\ \mathrm{m}s^{-2}$ $Deceleration = 1.875\ \mathrm{m}s^{-2}$	K1 G1 JU1 GJU1

	iii) $a = \frac{0 - v}{29 - 25}$ $-1.875 = \frac{0 - v}{29 - 25}$ $v = 7.5 \text{ m}s^{-1}$	G1
	$S_{t=25\to29} = \left(\frac{1}{2}\right)(v)(t)$ $S_{t=25\to29} = \left(\frac{1}{2}\right)(7.5)(4)$ $S_{t=25\to29} = 15\ m$	G1
	Distance moved by the car within 25s $= 112.5 + 150 - 15$ $d_{\text{t = 0s –> 25s}} = 247.5\ m$	K1 JU1
	OR	**OR**
	iii) $S_{25} = ut + \frac{1}{2}at^2$ $S_{25} = (15)(25 - 21) + \frac{1}{2}(-1.875)(25 - 21)^2$ $S_{25} = 45\ m$	G1 G1
	Distance moved by the car after 25s $= 112.5 + 90 + 45$ $d_{\text{t = 0s –> 25s}} = 247.5\ m$	K1 JU1
		8
(b)	$S_x = u_x t$ $100 = 10\cos30°t$ $t = 11.55\ s$	G1
	$v_y = u_y + at$ $v_y = (10 \sin30°) + (-9.81)(11.55)$ $v_y = -108.31 \text{ m } s^{-1}$	G1 JU1
		3

3.(a)

$$J = Area\ under\ F - t\ graph$$

$$(m)(v-u) = \left(\frac{1}{2}\right)(20)(4)$$

$$(5)(v-0) = 40$$

$$v = 8\ m\,s^{-1}$$

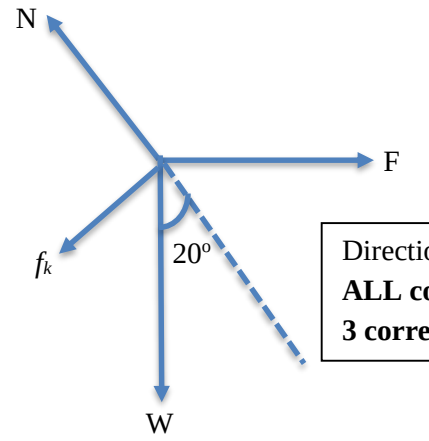
K1

GJU1

2

(b)

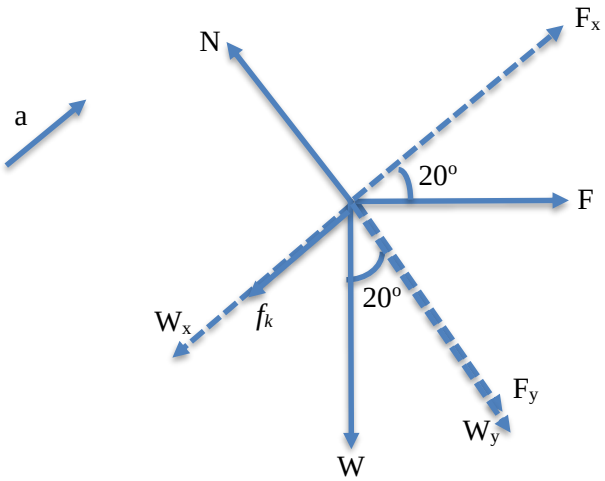
i)



Direction and label
ALL correct – D2
3 correct – D1

D2

ii)



$$\Sigma F_x = ma$$

K1

$$F_x - W_x - f_k = (15)(0.25)$$

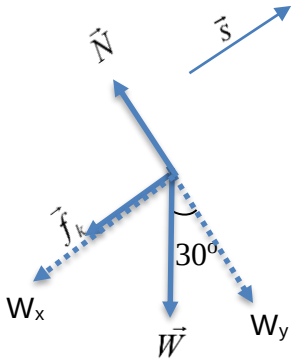
$$Fcos20° - Wsin20° - f_k = (15)(0.25)$$

G1

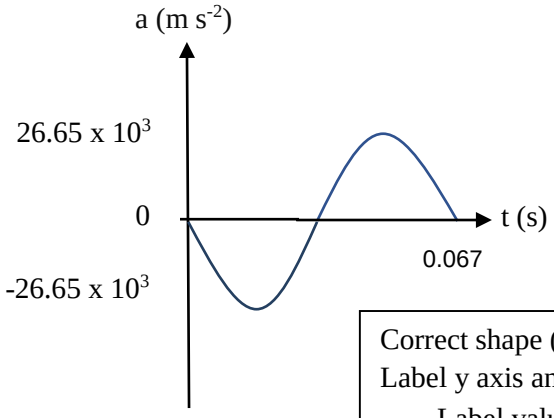
$$(200)cos20° - (15)(9.81)sin20° - f_k = (15)(0.25)$$

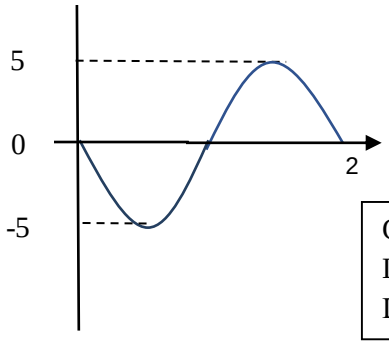
JU1

$$f_k = 133.9N$$

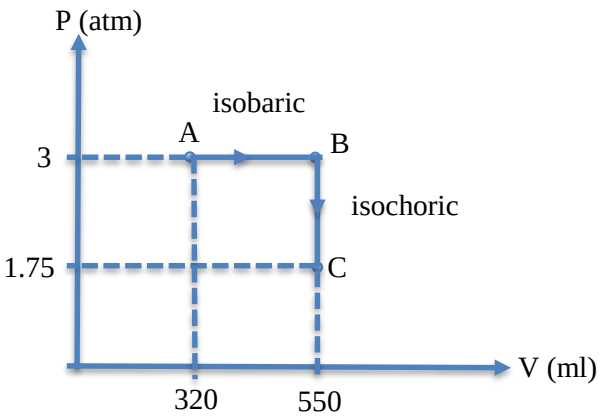
	iii) $\Sigma F_y = 0$ $N - W_y - F_y = 0$ $N - (15)(9.81)cos20° - (200)sin20° = 0$ $N = 206.68\,N$ $f_k = 133.9N$ $\mu_k N = 133.9N$ $\mu_k(206.68) = 133.9N$ $\mu_k = 0.65$	K1 G1 G1 JU1 **9**
4.(a)	$\Sigma E_i = \Sigma E_f$ $\mathrm{K} = U_g$ $\left(\frac{1}{2}\right)(m)(v) = mgh$ $\left(\frac{1}{2}\right)(m+M)(v)^2 = (m+M)gh$ $\left(\frac{1}{2}\right)(1.005)(v)^2 = (1.005)(9.81)(0.05)$ $v = 0.99\ m\ s^{-1}$	K1 G1 JU1 **3**
(b)	 $\sin 30° = \frac{h}{s}$ $0.5 = \frac{1.5}{s}$ $s = 3m$	G1

	$W = \Delta K$ $\left(\sum F_x\right) \bullet s = K_f - K_i$ $(-f_k - W_x)(s)(\cos\theta) = K_B - K_A$ $\left(-f_k - W\sin\theta\right)(s)(\cos 0°) = K_B - K_A$ $[(-\mu_k N) - mg\sin 30°](s)(1) = K_B - \frac{1}{2}mu^2$ $[-(0.20)(mg\cos 30°) - mg\sin 30°](3) = K_B - \frac{1}{2}(2)(14.14)^2$ $[-(0.20)(2.0)(9.81)(\cos 30°) - (2)(9.81)(\sin 30°)](3) = K_B - 199.94$ $-10.19 - 29.43 + 199.94 = K_B$ $K_B = 160.32J$	K1 K1 G1 G1 JU1 **6**
5.(a)	$\sum F_y = ma_c$ $T + mg = \frac{mv^2}{r}$ $T = \frac{mv^2}{r} - mg$ $T = \frac{(0.4)(4.0)^2}{(0.5)} - (0.4)(9.81)$ $= 8.876N$	K1 GJU1 **2**
(b)	$\sum F_x = F_c$ $F_c = \frac{mv^2}{r}$ $= \frac{(1000)(15)^2}{(50)}$ $= 4500N$ $f_s = \mu_s N$ $= (0.30)(mg)$ $= (0.30)(1000)(9.81)$ $= 2943N$ $\therefore f_s < F_c$ $\therefore 2943N < 4500N$ $\therefore$ The car **cannot go round the curve safely** when the road is wet with the coefficient of static friction $\mu_s = 0.30$	G1 G1 J1 **3**

6.(a)	**i)** $\omega = 2\pi f$ $= 2\pi(15)$ $= 30\pi$ rad s^{-1} $v = A\omega\, cos\omega t$ = (3)(30 π)cos [30π(1.5)] = -282.74 m s^{-1}	G1 G1 JU1
	ii) y = 3 – 1 = 2 m $v = \omega\sqrt{A^2 - y^2}$ $v = 30\pi\sqrt{3^2 - 2^2}$ $v = 210.74\, m\, s^{-1}$	K1 G1 JU1
	iii)  a = Aω^2 = (3)$(30\pi)^2$ = 2.66 ×$(10)^4$ $m\, s^{-2}$ $\omega = \frac{2\pi}{T}$ T = $\frac{2\pi}{30\pi}$ T = 0.067 s Correct shape (graph negative sin) - **D1** Label y axis and x axis and unit - **D1** Label value of a_{max} and T - **D1**	D3 **9**
(b)	**i)** $\omega = 2\pi f$ $= 2\pi(21)$ $= 42\pi$ rad s^{-1} $k = \frac{2\pi}{\lambda}$ $= \frac{2\pi}{2}$ $= \pi$ cm^{-1} y (x, t) = 5 sin (42πt - πx) x and y are in cm, and t is in s.	G1 G1 JU1

	ii) Displacement, y (cm)  At t = 0s, y = 5 sin (- πx) = -5 sin (πx) Correct shape (graph negative sin) -**D1** Label y axis and x axis with unit -**D1** Label value of A and λ -**D1**	D3 **6**
(c)	**i)** $\mu = \frac{m}{l}$ $= \frac{5x10^{-3}}{1.5}$ $= 3.33x10^{-3}\ kg\ m^{-1}$ $f_n = \frac{nv}{2l}$, n = 1 $100 = \frac{1v}{2(1.5)}$ V = 300 m s^{-1} $v = \sqrt{\frac{T}{\mu}}$ $v^2 = \frac{T}{\mu}$ $300^2 = \frac{T}{3.33x10^{-3}}$ T = 299.7 N	G1 G1 GJU1
	ii) $f_n = \frac{nv}{2l}$, n = 8 $f_8 = \frac{8(300)}{2(1.5)} = 800\ Hz$ **OR** $f_8 = 8f_1$ $f_8 = 8(100)$ $f_8 = 800\ Hz$	GJU1 **4**
(d)	Frequency received by the wall: $f_a = \frac{v + v_o}{v - v_s} f$ $f_a = \frac{340 + 0}{340 - 1.5}(700)$ $f_a = 703.10\ Hz$	K1 G1

	Frequency reflected from the wall to the girl: $$f_a' = \frac{v + v_o}{v - v_s} f$$ $$f_a' = \frac{340 + 1.5}{340 - 0}(703.10)$$ $$f_a' = 706.20\ Hz$$	GJU1 **3**
7 (a)	$$\sigma = \frac{F}{A}$$ $$500x10^6 = \frac{F}{\frac{\pi(0.2x10^{-2})^2}{4}}$$ F = 1570.8 N	G1 JU1 **2**
(b)	$$\frac{Q}{t} = -kA\frac{dT}{x}$$ $$\frac{Q}{t} = -0.84\ (4x4)\frac{(10 - 30)}{14x10^{-2}}$$ $$\frac{Q}{t} = 1920\ W$$ Number of bulb = $\frac{1920}{160}$ = 12 bulbs	G1 K1 JU1 **3**
(c)	Contract: $$\Delta l = \alpha l_0 \Delta T$$ $$\Delta l = 12x10^{-6}(200)(-30 - 32)$$ $$\Delta l = -0.15\ m$$ Expand: $$\Delta l = \alpha l_0 \Delta T$$ $$\Delta l = 12x10^{-6}(200)(42 - 32)$$ $$\Delta l = 0.024\ m$$	G1 JU1 GJU1 **3**

8 (a)	$PV = nRT$ $(2.9x1.013x10^5)(5) = 2100(8.31)(T)$ $T = 84.17\ K$ $V_{rms} = \sqrt{\frac{3RT}{M}}$ $V_{rms} = \sqrt{\frac{3(8.31)84.17}{0.028}}$ $V_{rms} = 273.75\ m\ s^{-1}$	G1 G1 JU1 **3**
(b)	**i)**  $T_A = T_C$ $P_A V_A = P_C V_C$ $(3)(320) = (P_C)(550)$ $P_C = 1.75$ atm Isobaric – **D1** Isochoric – **D 1** Label y axis and x axis with unit & value (A to B and B to C) – **D1**	D3
	ii) $W_{AB} = PdV$ $W_{AB} = 3x1.013x10^5(550x10^{-6} - 320x10^{-6})$ $W_{AB} = 69.90\ J$ $W_{BC} = 0$ $W_T = W_{ABC} = 69.90 + 0$ $= 69.90\ J$	G1 K1 GJU1
	iii) ΔU_{ABC}=0 $Q_{ABC} = \Delta U_{ABC} + W_{ABC}$, $Q_{ABC} = 0 + 69.90$ $Q_{ABC} = 69.90$ J	K1 GJU1 **8**