SP015
Physics 1
Semester I
Session 2022/2023
2 hours

SET A

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PROGRAM DRAW A QUESTION (DAQ)

MODEL PAPER SEMESTER I
PHYSICS UNIT

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.

QUESTION	MARKS
1	/2
2	/10
3	/13
4	/8
5	/5
6	/23
7	/8
8	/11
TOTAL	/80

*This question paper consists of **12** 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
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}

LIST OF SELECTED CONSTANT VALUES
SENARAI NILAI PEMALAR TERPILIH

Atomic mass unit *Unit jisim atom*	1 u	$= 1.66 \times 10^{-27}$ kg $= 931.5 \frac{\text{MeV}}{c^2}$
Electron volt *Elektron volt*	1 eV	$= 1.6 \times 10^{-19}$ J
Constant of proportionality for Coulomb's law *Pemalar hukum Coulomb*	$k = \frac{1}{4\pi\varepsilon_0}$	$= 9.0 \times 10^{9}$ 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. $P_{av} = \dfrac{\Delta W}{\Delta t}$
15. $P = \vec{F} \cdot \vec{v} = Fv\cos\theta$
16. $a_c = \frac{v^2}{r} = r\omega^2 = v\omega$
17. $F_c = \frac{mv^2}{r} = mr\omega^2 = mv\omega$
19. $v = r\omega$
20. $a_t = r\alpha$
21. $\omega = \omega_o + \alpha t$
22. $\theta = \omega_o t + \dfrac{1}{2}\alpha t^2$
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. $I_{\text{solid sphere}} = \dfrac{2}{5}MR^2$
28. $I_{\text{solid cylinder/disc}} = \dfrac{1}{2}MR^2$
29. $I_{\text{ring}} = MR^2$
30. $I_{\text{rod}} = \dfrac{1}{12}ML^2$
31. $\sum\tau = I\alpha$

LIST OF SELECTED FORMULAE
SENARAI RUMUS TERPILIH

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. $k = \frac{2\pi}{\lambda}$

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. $\Delta L = \alpha L_\circ \Delta T$

60. $\Delta A = \beta A_\circ \Delta T$

61. $\Delta V = \gamma V_\circ \Delta T$

62. $\beta = 2\alpha$

LIST OF SELECTED FORMULAE
SENARAI RUMUS TERPILIH

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. $PV = \frac{1}{3} N m {v_{rms}}^2$

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

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

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

74. $W = \int P dV = 0$

Answer **all** questions.

1. A man walks 5 m at 40^{o} north of east and then 10 m to the south. Calculate the resultant of vertical displacement.

[2 marks]

2. (a) A car moves linearly in the direction of positive *x*-axis. The graph in **FIGURE 1** shows the car's velocity as a function of time. Calculate the car's average velocity during the first 3 seconds?

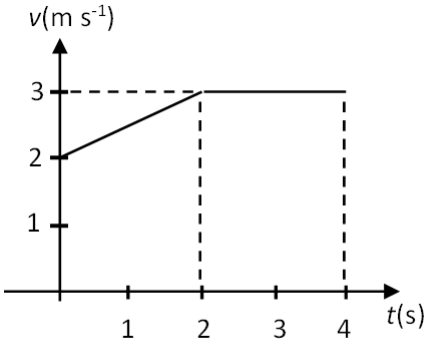

FIGURE 1

[4 Marks]

(b) A cheetah running with a constant acceleration covers the distance between two points 90 m apart in 6.70 s. Its speed as it passes the second point is 15 m s^{-1}. Calculate the cheetah's speed at the first point.

[3 Marks]

(c) An object is projected at an angle of 40° below the horizontal from the cliff of height 90 m. After 3.5 s, it reaches the ground. Calculate

i. the speed of projection of the object.

ii. the horizontal displacement of the object.

[3 Marks]

3. (a) A 15.0 g bullet moving 250 m s^{-1} to the right strikes a log. Assume that the bullet undergoes uniform deceleration and stops in 10 s. Find the average force experienced by the bullet and state its direction.

[3 marks]

(b)

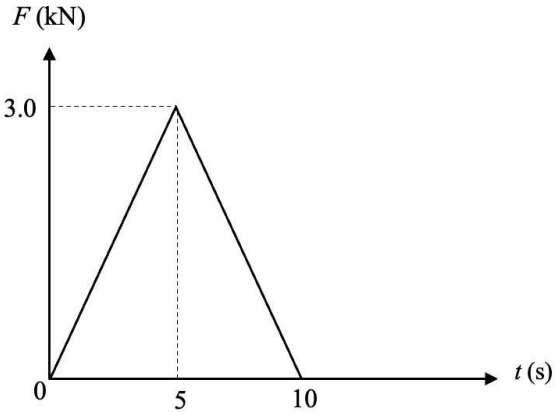

FIGURE 2

FIGURE 2 shows a variation of force with time when a car hits a wall. Calculate the impulse of the car.

[3 marks]

(c)

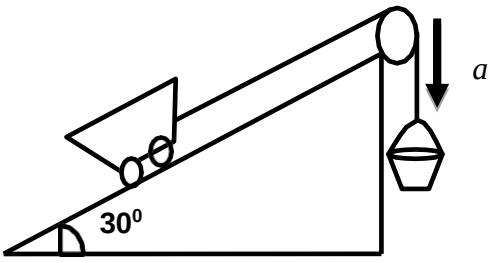

FIGURE 3

FIGURE 3 shows a 12.0 kg wheelbarrow placed on a frictionless plane inclined at 30^o with the horizontal connected to a 7.0 kg hanging bucket by a string that passes over a pulley.

(i) Sketch a labelled free body diagram showing all the forces on the 12.0 kg wheelbarrow.

(ii) Calculate the acceleration of the system.

[7 marks]

4. (a) The graph in **FIGURE 4** shows how the force *F* on a body of mass 8 kg varies with displacement from the origin.

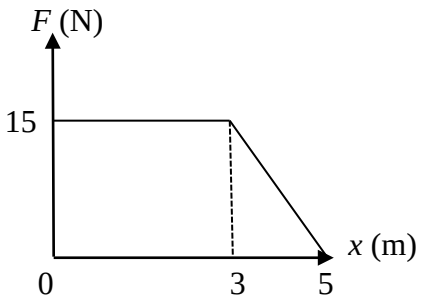

FIGURE 4

(i) What is the work done by the force when the body is displaced 5.0 m from the origin?

(ii) The velocity of the body at the origin is 6.0 m s^{-1}. What its velocity when it is 5.0 m from the origin?

[5 marks]

(b) A 0.5 kg ball is released from rest and falls under gravity through a height 6 m from the ground. What is the kinetic energy of the ball just before it hits the ground?

[3 marks]

5. A toy car moving at a constant speed completes one lap around a 200.0 m circular track in 25.0 s.

(i) Calculate the speed of the car.

(ii) Determine the magnitude of the centripetal force that keeps the car in a circle if its mass is 1.5 kg.

[5 marks]

6. (a) A simple harmonic oscillator consists of a block attached to a spring with spring constant, k = 250 N m^{-1}. The block slides back and forth along a straight line on a frictionless surface. A graph of the block's velocity against time is shown as in **FIGURE 5**.

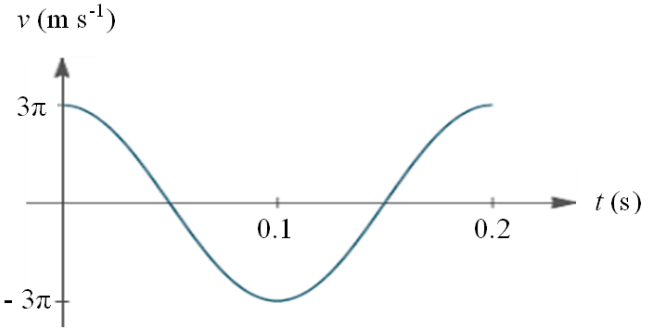

FIGURE 5

Determine

(i) the angular frequency,

(ii) the amplitude,

(iii) the mass, and

(iv) the maximum kinetic energy of the block.

[8 marks]

(b)

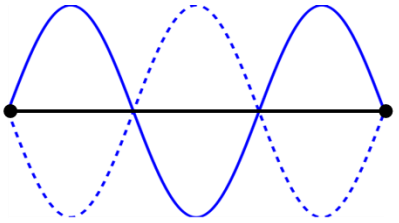

FIGURE 6

Two sinusoidal waves with the same amplitude and wavelength travel in opposite direction along a string that is stretched along an axis. Their resultant wave is shown in **FIGURE 6**. The distance between nodes and adjacent antinodes is 2 cm. The mass of the string is 35 g and the tension force applied is 50 N.

Determine

(i) the speed of waves travelling along the string.

(ii) the wavelength and frequency of the standing waves formed.

[7 marks]

(c) A pipe, open at both ends is 85 cm long. Find the frequency of

(i) fundamental,

(ii) second harmonic, and

(iii) third overtone

produced by this pipe if the speed of sound in air is 343 m s^{-1}.

[4 marks]

(d) A car moving at a constant speed of 30 m s^{-1} passes a stationary siren. The siren emits a sound of 400 Hz. If the speed of sound is 340 m s^{-1} and the apparent frequencies of the sound heard by the passenger in the car are f_1 and f_2 respectively while approaching and leaving the source. Determine

(i) the frequency, f_1.

(ii) the frequency, f_2.

[4 marks]

7. (a) A copper wire with initial length of 0.755 m and cross-sectional area of 3.75×10^{-7} m^2 is stretched until the strain in the wire is 0.015. Calculate

(i) the force applied

(ii) the strain energy in the wire

[Young Modulus of copper is 1.30×10^{11} Pa.]

[5 marks]

(b)

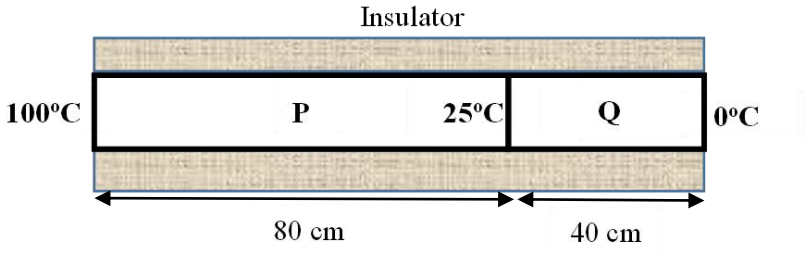

FIGURE 7

Metal rods **P** and **Q** are well insulated as in **FIGURE 7**. The thermal conductivity of metal rods **P** and **Q** are k_p and k_Q respectively. Calculate the value of $\frac{k_P}{k_Q}$?

[3 marks]

8. (a) A 1.5 mol ideal monoatomic gas is stored in a container at 25°C. Calculate the

(i) translational kinetic energy per molecule.

(ii) internal energy of the gas.

[4 marks]

(b) An ideal gas has a molar mass 46 g mol^{-1}. Calculate the root mean square speed of the molecules at -10℃.

[2 marks]

(c) A cylinder fitted with a smooth piston contains 1.2 moles of ideal gas. Initially the gas has a volume of 7.2 $\times 10^{-2}$ m^3 at a pressure of 38 kPa. The gas expands isothermally until its volume increases to 22.5 $\times 10^{-2}$ m^3 and then compressed isovolumetrically back to its initial pressure.

(i) Sketch a labelled $P - V$ graph of the thermodynamics process.

(ii) Calculate the work done by the gas in the isothermal process.

[5 *marks*]

END OF QUESTIONS