1974 1974 Blank Score → 131.4 / 180

MCM

BL 22/35 → 28.3/45 SL

1) not dep. mass (c) ✓

2) $0 = mv_0 - Mv_f$

$Mv_f = mv_0$

$v_f = \frac{m}{M} v_0$ (b) × e

3) $\int v\,dt = \frac{1}{3}bt^3$ (b) ✓

4) $\sqrt{2gh}$ (c) ✓ (memory)

5) $\frac{1}{2} I_0 \omega_0^2 = \frac{1}{2} \cdot \frac{1}{2} I_0 \omega_f^2$

$\omega_f^2 = 3\omega_0^2$

$\omega_f = \sqrt{3}\,\omega_0$ (d) × e

6) $\sum F_{ext} = m_T a$ (e) × b

7) $L = mvr$ L conserved (a) ✓

8) $W = \int F\,dx = \Delta KE = \frac{1}{2} m \cdot u^2$

$= 40\,J$ (a) × c

9) $\mu_s mg = \frac{mv^2}{r}$

$v = \sqrt{\mu_s g r} = \sqrt{0.5 \cdot 10 \cdot 10} = \sqrt{200}$

$= 10\sqrt{2} \approx 14.1$

(d) ✓

10) $\int v\,dt$ (e) ✓

11) (a) ✓ 12) (c) ✓

-4

13) $\omega_f = \omega_0 + \alpha t$

$\alpha = \frac{-\omega_0}{t} = \frac{-12 \frac{rad}{s} \cdot 2\pi \frac{rad}{rev} \cdot \frac{1}{6}}{}$

$= 4\pi$ (d) ✓

14) $2m v_0 = 5m v_f$

$v_f = \frac{2}{5} v_0$ (b) ✓

15) $\int_0^L (ax + bx^3)\,dx$

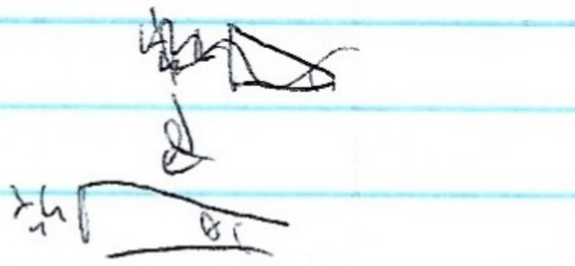
$= \frac{1}{2}ax^2 + \frac{1}{3}bx^3 \Big|_0^L$ (e) ✓

16) $\frac{d}{dx}(PE_x) = +mg + bx$ (e) ✓

17) $mgh = \frac{1}{2} m v_f^2$

$\frac{1}{2} m \left(\frac{1}{2} v_f\right)^2 = mgl$

$l = \frac{1}{4} h$



$d = \frac{\frac{1}{4}h}{\sin\theta} = \frac{\frac{1}{4}h}{h/L} = \frac{1}{4}L$ (a) ✓

18) $\frac{dv}{v^2} = -kt\,dt$

$-\frac{1}{v} = -\frac{1}{2}kt^2 + t_1$

(c) ✓

19) (c) × a 20) $U_2 \frac{GMm}{r}$

$U_0 = \frac{GMm}{R_1}$ $U_f = \frac{GMm}{R_2}$ $\left(\frac{1}{R_2} - \frac{1}{R_1}\right)$

$= \left(\frac{R_1 - R_2}{R_1 R_2}\right)$

(d) ✓

-1

21) $\frac{dy}{dx} = \frac{+R\omega\sin\omega t}{\omega R - R\omega\cos\omega t}$

$\frac{d^2y}{dx^2} =$ (a)

$\Sigma F = \frac{mv^2}{r} = m\omega^2 r$

$a = r\omega^2$ (b) ✓

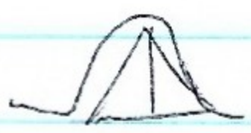
22) $\Delta E = mgh = 100N$ (a) ✓

23) $mg = \alpha x^2$

$x = \sqrt{\frac{mg}{\alpha}}$ (a) ✗ b

24) $\sqrt{3}R$ (a) $J = \Delta p = m\Delta v = \int F \cdot dt$

$\Delta v = \frac{\int F \cdot dt}{m} = \frac{4}{5} = 0.8$ (a) ✗ b



26) $\frac{1}{2}mgh = \frac{1}{2}mv_c^2 + \frac{1}{2}I\omega_c^2$

$mgh = \frac{1}{2}mv_f^2 + \frac{1}{2}I\omega_f^2$ (c) ✗ d

27) L conserves. UE ↓ when frictionless

(e) ✓

28) $\frac{1}{2}k\left(\frac{A}{2}\right)^2 + KE = 50$

$\frac{1}{2}kA^2 = 50$ $\frac{1}{4} \cdot 50 + KE = 50$

$KE = 37.5$ (d) ✓

29) (b) ✗ e 30) (c) ✓

31) $P = F\bar{v}\cos\theta = kv^2\cos\theta$ (b.) ✗ e

32) (a) ✓ 33) $ab/c\,dy$

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

$v_y^2 = v_{0y}^2 + 2gy$ (a) ✓

$y = \frac{1}{2g}v_{0y}^2$

34) $mv_f \cdot$ answer (c) ✗ b

35) $W = \int F\,dr = F_0\int_0^\infty e^{-kx}\,dx$ (b) ? ✗ a

1) e 3) b 6) b 8) c 19) d

23) b 24) d 25) b 26) d 29) e 31) c

34) b 35) a

-2

-6

1974 MCE

BL - 25/35 → 32.1/45 SC

36) $E = \frac{kQ}{R^2} = \frac{k(1.8\times10^{-4}\,L)}{(0.10\,m)^2} = 900\ V/m$ (c) ✓

37) (e) ✓

38) $C = \frac{Q}{V}$ $I = \frac{V}{R}$ $V_b = IR$

(d) × a =

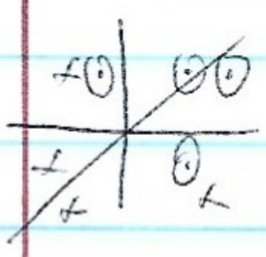
39) $P = I^2R$

$I = \sqrt{\frac{P}{R}} = \sqrt{\frac{1\,kW\cdot h / 0.5h}{20\,\Omega}}$ $P = \frac{W}{t}$

$= 10\,A$ (a) ✓

40) $P = \frac{V^2}{R}$ (b)? × e

41)



(e) ✓

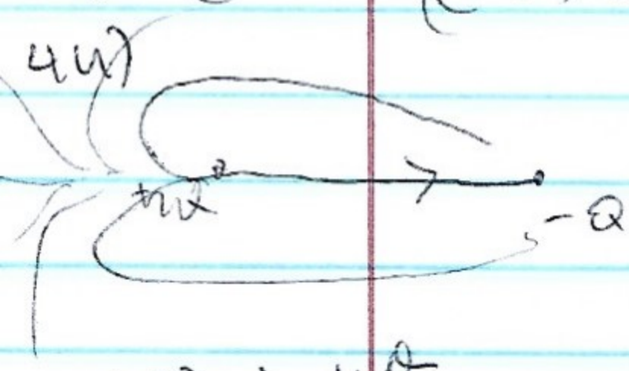
42) $\varepsilon = \frac{d\Phi}{dt} = \frac{BdA}{dt} = BA\cdot\frac{d}{dt}\cos\omega t$

$= BAb\omega\cos\omega t$ (d) ✓

43) $I = \frac{12V}{10\,\Omega} = 1.2\,A$

$\Delta V = (1.2)3 + (1.2)6 = 10.8\,V$ (b) ✓

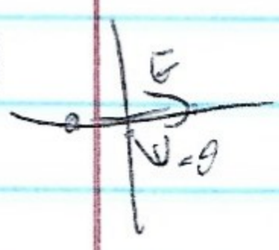
44)



(a) × d

45) $V = \frac{kQ}{R}$ $E = \frac{kQ}{R^2}$

a)



b)

(e) ✓

-3

46) (d) ✓

47) B → − x (d) × a ΔB(x)

48)

(e) ✓ 49) (d) × b

50) (a) ✓ 51) BA cos θ πr^2 $\frac{1}{4}$ (e) ✓

52) $\varepsilon = -L\frac{dI}{dt}$ (a) ✓ 53) 4.3 (d) ✓

54) $I_1 = \frac{V}{R} = 2A$ (c) ✓ ✓

55) (e) low R, greater P

56) $U = qV$ (d) ✓ 57) (b) × a

58) $V_{ja} = IR = 2V$ (e) ✓

59) (a) × b 60) $\frac{d\Phi}{dt}$ → const.

$\varepsilon = IR$

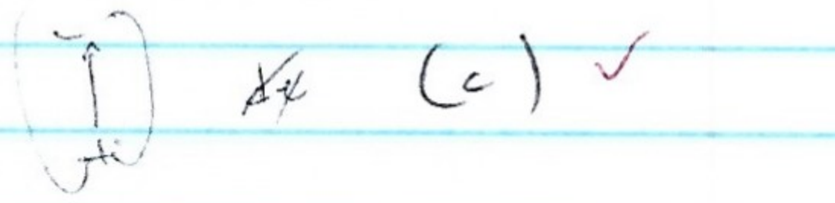
$I = \frac{\varepsilon}{R}$ → const.

(c) ✓

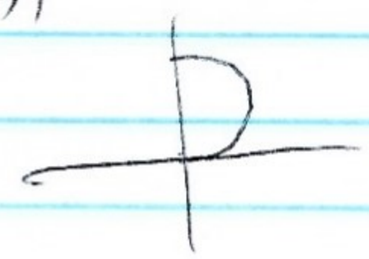
61) wtf? (c)? ✓

62) (b) × e 63) ⊙ (d) × b

64)



65)



$F_c = \frac{mv^2}{r} = qvB$

$r = \frac{mv}{qB}$

$y = 2r$ (b) ✓

-7

66) Thevenin equivalent (d) ✓

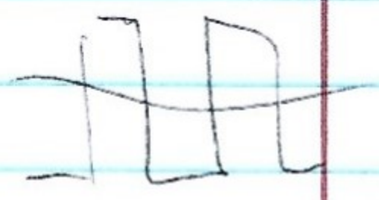
67) $C = \frac{k\varepsilon_0 A}{d}$ Q const.

$V = \frac{Q}{C}$ V doubled

$\varepsilon_{\text{halves}}$

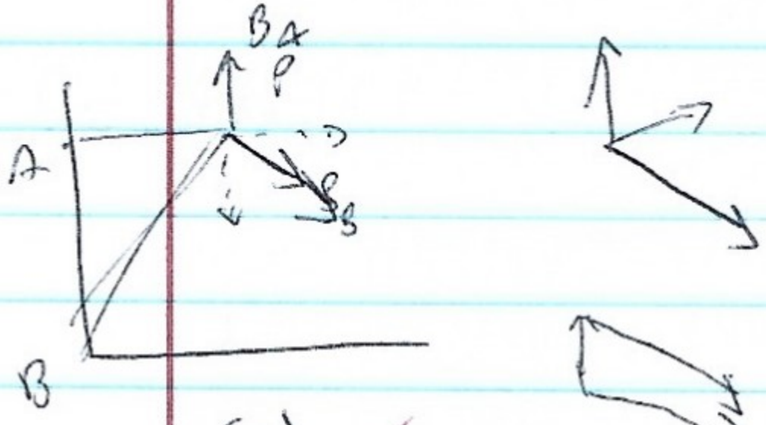
$U = \frac{1}{2}QV$ (d) ✓

68) $L\frac{di}{dt}$



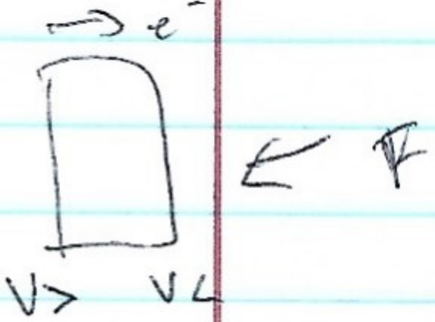
(b) ✓

69)



(a) ✓

70)

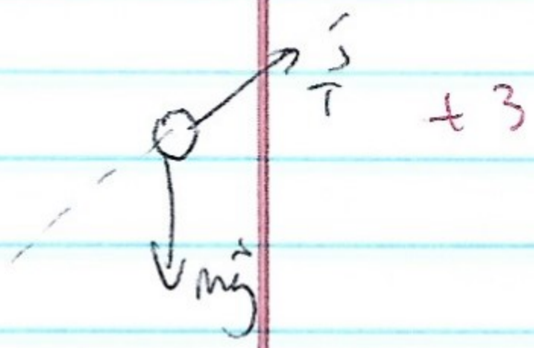


(a) ✓

AP 1974 FRQ

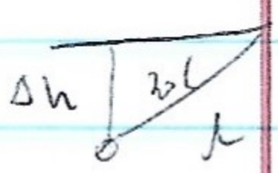
B2 - 2a/4/5

1) a)



+3

b)



$\Delta h = l \sin\theta$

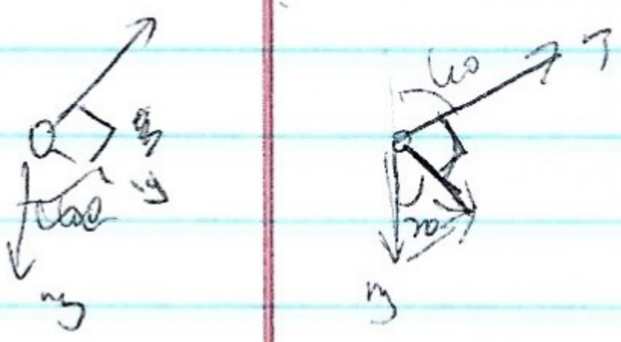
$mg\Delta h = \frac{1}{2} m v_f^2$

$v_f^2 = \sqrt{2gl\sin\theta}$ $\quad \sin 30 = \frac{1}{2}$

$= \sqrt{gl}$ +3

c) $T = F_c = \frac{mv^2}{r} = \frac{mv^2}{l} = \frac{mgl}{l} = \boxed{mg}$ +10

d) $a_t = r\alpha$



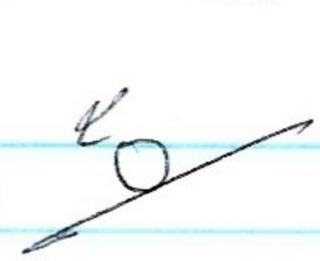
$F_{circ} = mg\cos 30 = \frac{\sqrt{3}}{2} mg$

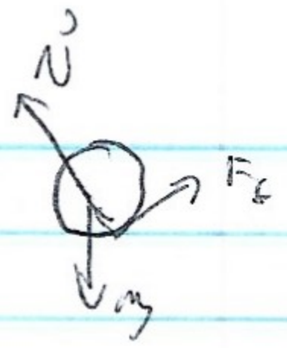
$ma_t = \sum F = F_{circ}$

$\boxed{a_t = \frac{\sqrt{3}}{2} g}$ +3

9/15

2)





a) $\sum \tau = I\alpha$

$\mu mg\cos\theta R = I\alpha = I\frac{a}{R}$

$\sum F = ma = mg\sin\theta$ $\quad a = g\sin\theta$

$\mu mgR\cos\theta = \frac{2}{5} mR^2 \cdot \frac{g\sin\theta}{R}$

$\mu mg\cos\theta = \frac{2}{5} mg\sin\theta$

$\sum F = ma = g\sin\theta - \mu mg\cos\theta$

$a = \frac{g\sin\theta}{m} - \mu g\cos\theta$

$\mu mgR\cos\theta = \frac{2}{5} mR^2 \cdot \left(\frac{g\sin\theta}{m} - \mu g\cos\theta\right)$ / R

$\mu mgR\cos\theta = \frac{2}{5} mR(g\sin\theta - \mu g\cos\theta)$

$\mu\cos\theta = \frac{2}{5}\sin\theta - \frac{2}{5}\mu\cos\theta$

$\frac{7}{5}\mu\cos\theta = \frac{2}{5}\sin\theta$

$\boxed{\mu = \frac{2}{7}\tan\theta}$ +10

b) greater → if the sphere slides down the frictionless ramp, less energy is converted to rotational KE, which means the linear speed will be greater.

+5

15/15

3) a) $\frac{1}{2}kD^2 = \frac{1}{2}Mv_{max}^2$

$v_{max} = \sqrt{\frac{kD^2}{M}}$ ✓

b) $\frac{1}{2}kD^2 = \frac{1}{2}(2M)v_f^2$

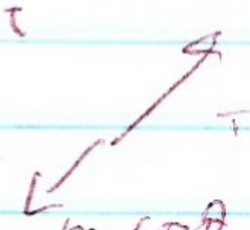
$v_f = \sqrt{\frac{kD^2}{2M}}$ ✗

c) $T_s = 2\pi\sqrt{\frac{M_e}{k}}$

$= 2\pi\sqrt{\frac{2m}{k}}$ ✗

5/10

1) c) $\sum F = ma = ma_r + ma_t$



$ma_r = T - mg\cos 60$

$\frac{mv^2}{l} = T - \frac{1}{2}mg \rightarrow v = \sqrt{gl}$

$T = \frac{3}{2}mg$

3) b) $\nu = \frac{1}{2}\sqrt{\frac{k}{m}}$, cons.

$v = \frac{v_{max}}{2}$

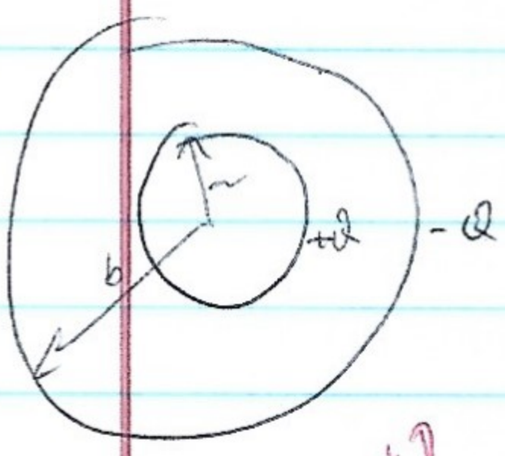
c) $m_r = \frac{m}{2}$ $T = \nu_r\sqrt{\frac{m_r}{k}}$

$= \nu_r\sqrt{\frac{m}{2k}}$

Q74 FLB

42/45

1) a)



+2

a) r<a: $\int E \cdot dA = \frac{Q_{en}}{\varepsilon_0}$ $Q_{en} = 0$

+2

$E = 0$

a<r<b: $\int E \cdot dA = \frac{Q_{en}}{\varepsilon_0}$ $Q_{en} = +Q$

$E \cdot 4\pi r^2 = \frac{Q}{\varepsilon_0}$

$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{r^2}$ +2

r>b: $\int E \cdot dA = \frac{Q_{en}}{\varepsilon_0}$ $Q_{en} = Q - Q = 0$

$E = 0$ +2

b) r=b $V = \frac{kQ}{b} - \frac{kQ}{b} = 0$ +2a

r=a $V = \frac{kQ}{a} - \frac{a}{b}\cdot\frac{kQ}{a} = \frac{kQ}{a} - \frac{kQ}{b}$

$= kQ\left(\frac{1}{a} - \frac{1}{b}\right)$

+2a

+7

15/15

2) a) $C = \frac{\kappa\varepsilon_0 A}{d} = \frac{\varepsilon_0 A}{b}$

$E = -\frac{dV}{dr} = -\frac{\Delta V}{\Delta r} = \boxed{\frac{V}{b}}$ +2

b) $Q = CV = \frac{\varepsilon_0 A}{b} \cdot V = \boxed{\frac{\varepsilon_0 A V}{b}}$ +4

c) 2 capacitors in series

$d = \frac{b-a}{2}$ → +1

Voltage!

$E = \boxed{\frac{2V}{b-a}}$ in both regions

x

d) $C_T = \left(\frac{2\varepsilon_0 A}{b-a}\right) \cdot \frac{1}{2}$ ← 2 in series → -3

$= \frac{\varepsilon_0 A}{b-a}$

$\frac{\frac{\varepsilon_0 A}{b-a}}{\frac{\varepsilon_0 A}{b}} = \boxed{\frac{b}{b-a}}$ +5

12/15

c) $dB = \frac{\mu_0}{4\pi} \cdot \frac{I\, dl \times \hat{R}}{R^2}$

$B = \frac{\mu_0 I \cdot 2\pi R}{4\pi R^2} = \frac{\mu_0 I}{2R}$ + 8

$B = \frac{\mu_0 I_0 \sin \omega t}{2R}$

$\mathcal{E} = \frac{d\Phi}{dt} = A \cdot \frac{dB}{dt}$

$= \pi r^2 \cdot \frac{d}{dt} \cdot \left(\frac{\mu_0 I_0 \sin \omega t}{2R} \right)$

$= \pi r^2 \cdot \frac{\mu_0 I_0}{2R} \cdot \frac{d}{dt} \sin \omega t$

$= \frac{\pi r^2 \cdot \mu_0 I_0}{2R} \omega \cos \omega t$ +4

$= \boxed{\frac{\pi r^2 \mu_0 I_0 \omega \cos \omega t}{2R}}$ +3

Signs is fine

15/15

2) c) → Voltage is unit;

$\boxed{C = \frac{V}{b-a}}$ in each section