Paper 1

1. $P = Fv$ $\quad$ $N\,m\,s^{-1}$

$\quad = mav$ $\quad$ $kg\,m\,s^{-2}\,m\,s^{-1}$ $\quad$ D

don't forget about me!

$kg\,m^2\,s^{-3}$

2. $\rho = \frac{m}{V}$ $\quad$ so $\frac{\Delta \rho}{\rho} = \frac{\Delta m}{m} + 3\frac{\Delta l}{l}$ $\quad$ D

$\rho \propto \frac{m}{l^3}$ $\quad$ "percentage uncertainty" $= 8\% + 3 \times 4\%$

$= 20\%$

3. $s = ?$ $\quad$ $v^2 = u^2 + 2as$

$u = 20$ $\quad$ $0 = 20^2 + 2(-4)s$

$a = -4$ $\quad$ $8s = 400$ $\quad$ C

$v = 0$ ← "stop" $\quad$ $s = 50\,m$

4. Notice the axes! BUT "projectile", "air resistance negligible"

(→) no force, velocity constant

(↓) resultant force, magnitude increases $\quad$ A

5. Notice the axes! Need an equation without t...

$v^2 = u^2 + 2as$ $\quad$ "a constant" $\quad$ $v^2 \propto s \therefore v \propto \sqrt{s}$ $\quad$ A

6. Consider X... it's accelerating (→) so needs

X →

Frictional forces are same type acting on different bodies. It's an N3 pair!

← Y

(A)

7. Circular motion so resultant force is towards centre (horizontal, incidentally). Force and velocity are always at right angles so no work done. (A)

8. Energies! EPE of spring → KE of object

$$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 \quad \text{(for diagram)}$$

$$x^2 \propto v^2$$

$$x \propto v$$

(B)

don't know ↘

9. Impulse = Ft ← don't know

change in momentum → ~~$= mv_f - mu$;~~ ← (better!) →

~~$= m($~~

~~Impulse $\propto \Delta p$~~

~~75% energy~~

~~$KE = \frac{1}{2}mv^2 = \frac{1}{2}\frac{p^2}{m}$~~

~~$\Delta p = \Delta\sqrt{2 \cdot KE \cdot m}$~~

↑ only quantity changing

☆ Come back to this one?! ☆

9. $\overset{m}{\circ}\longrightarrow v$ before

$v' \longleftarrow \circ$ after

Impulse $= \Delta p$

direction $\longrightarrow$ $= -mv' - (mv)$

$= -m(v' + v)$

$$\frac{1}{2}m(v')^2 = \frac{1}{4} \times \frac{1}{2}mv^2$$

since 75% lost

$$(v')^2 = \frac{v^2}{4}$$

$$v' = \frac{v}{2}$$

$$= -\frac{3}{2}mv$$

Ⓓ

NB: magnitude

10. $c = \frac{Q}{m\Delta\theta} = \frac{Pt}{m\Delta\theta}$

units ↗

Δ temperature so °C ok :)

$t = \frac{mc\Delta\theta}{P} = \frac{1 \times 420\cancel{0} \times \cancel{70}}{\cancel{70}\cancel{0}}$ Ⓒ

$= 420$ seconds $= 7$ minutes

11. "same temperature" so same average KE

$KE = \frac{1}{2}mv^2$ so $v \propto \frac{1}{\sqrt{m}}$

$\frac{v_{He}}{v_O} = \sqrt{\frac{m_O}{m_{He}}} = \sqrt{8}$ Ⓒ

12. $\frac{p_1 V_1}{n_1 T_1} = \frac{p_2 V_2}{n_2 T_2}$

$\frac{p_1 V_1}{p_2 V_2}\frac{n_2}{n_1} = \frac{T_1}{T_2} = 2 \times \frac{1}{4} \times 2 = 1$ Ⓒ

13. $f = \frac{\text{revolutions}}{\text{time}} = \frac{5}{3}$ Hz Ⓑ

↗ angle not needed here

14. Any wave: propagation parallel to energy transfer

Longitudinal: oscillations of medium parallel Ⓑ

15. Look for complete cycle : · 8 m
· 10 ms

$$\text{speed} = \frac{x}{t} = \frac{8}{10 \times 10^{-3}} = 800 \text{ ms}^{-1}$$

Ⓓ

16. Decrease in fringe spacing means <u>less</u> spread

I. $\uparrow x$ will increase spread ✗ (since more space to travel)

II. $\uparrow d$ will reduce spread ✓ (since $y \propto \frac{1}{d}$)

III. $\lambda_{green} < \lambda_{red}$ so will reduce spread ✓ (since $y \propto \lambda$)

Ⓒ

17. "Same speed" and "<u>same</u> frequency"

L_1

L_2

$= 3L_1$

Ⓓ

18. $I = nAve$

$\overset{\nwarrow}{} \ \overset{\uparrow}{} \ \overset{\nearrow}{}$ constant

· in series · both copper

$$v \propto \frac{1}{A} \propto \frac{1}{\text{diameter}^2}$$

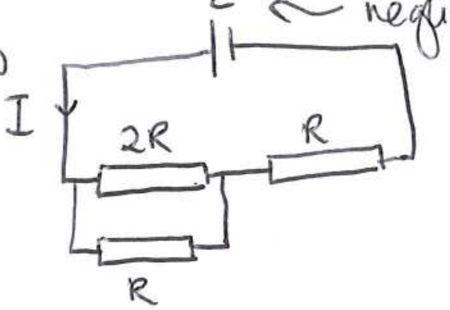
$$\frac{v_Y}{v_X} = \frac{1}{4}$$

Ⓐ

19. $P = \frac{V^2}{R}$ $\quad P \propto \frac{1}{R} \propto \frac{1}{l}$ ← since $R = \rho \frac{l}{A}$

l doubles so P halves Ⓑ

20. Redraw



← negligible r'

Combined resistance

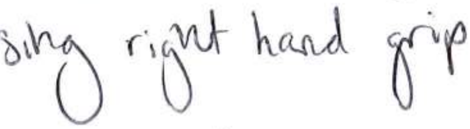
$$\frac{1}{\frac{1}{2R} + \frac{1}{R}} + R$$

$$= \frac{2R}{3} + R = \frac{5R}{3}$$

$$I = \frac{\varepsilon}{\frac{5R}{3}} = \frac{3\varepsilon}{5R}$$

Two thirds goes through X so $\frac{2}{3} \times \frac{3\varepsilon}{5R} = \frac{2\varepsilon}{5R}$ Ⓒ

21.



- left and right cancel
- resultant upward Ⓐ

Using right hand grip

22. Fleming's left hand rule: ① field (into page)
② force (down)

Conventional current is left! Must be negative.

$F = Bqv$

$\frac{mv^2}{R} = Bqv$ $\quad \Rightarrow v = \frac{BqR}{m}$ Ⓑ

23. $F(\leftarrow) = F(\rightarrow)$ NB: $F_G = \frac{GMm}{r^2}$

$$\frac{4M}{(1-x)^2} = \frac{9M}{x^2}$$

$$4x^2 = 9(1-x)^2$$

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

$$5x = 3$$

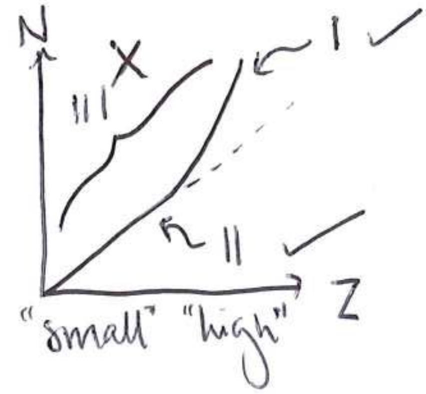
[✓ C]

24. Half life is 50s (don't be fooled by non-origin scale)

200s is four $t_{\frac{1}{2}}$ $100\% \xrightarrow{1} 50\% \xrightarrow{2} 25\% \xrightarrow{3} 12.5\% \xrightarrow{4} 6.3$

[✓ B]

25.



[✓ A]

26. $^{64}_{29}Cu \rightarrow ^{64}_{28}Ni + ^{0}_{+1}\beta^{+} + \nu$ ∴ W^{+} from recall

64-64

29-28

[✓ D]

27. Baryon number: $\underset{\text{proton}}{1} + 0 \rightarrow 0 + 0$ ★ violated ★

Charge: $1 + (-1) \rightarrow (-1) + 1$

Strangeness: $0 + 0 \rightarrow \underset{\text{since 's'}}{-1} + 0$ ★ violated ★

B

28. Control rods <u>prevent</u> neutrons reaching fuel rods D

(NB: The moderator slows neutrons to produce <u>more</u> successful collisions)

29. $P \propto$ efficiency × area ← I assume to power '1'! So eA is constant ("same power")

$$20\delta = 15A$$
$$\frac{4}{3}\delta = A$$

D

30. $\alpha = \frac{\text{reflected}}{\text{received}}$

$P = \underset{(\text{snow})}{0.8 I_0} \times \underset{(\text{cloud})}{0.3}$

NB: $0.8 = \frac{4}{5}$ ⟶ $= 0.24 I_0$

and $\frac{0.3}{5}$ is 0.06

B