# ANSWERS TO P12 EOS-2 THIRD EXAM PAPER

## SECTION 1

2.     1250 Hz (estimate)

3a)  (bullets 2 and 3 are main ones)
- As part B extends, the path length increases.
- As the PD reaches ½ , destructive interference occurs and the intensity falls.
- When PD reaches $1\lambda$ constructive interference occurs, and intensity increases.
- This continues with soft then loud alternately.

3b)
- make lengths give antinodal point.
- Extend part B until next antinode occurs.
- Measure extension of part B
- PD = 2 x extension (x) i.e. 2x
- Interantinodal distance = ½ $\lambda$  [1 mark]
- 2x = ½ $\lambda \Rightarrow \lambda$ = 4x  [1 mark]

3c)  Need to know the frequency, then  v = f x $\lambda$  $\Rightarrow$  v = f $\times$ 4x

4.   (-1 mark each error or omission)
  a) radio waves   b) visible   c) microwaves   d) UV   e) X-rays or gamma rays   f) X-rays or gamma
  g) Infrared   h) microwaves

5.  [1 mk direction of convention current; 1 mk N/S; 1 mk mag field; 1 mk direction of Force]
   Note: Magnetic field lines should show a minimum of 3 out of LHS S-pole and into RHS N-pole. Also

   minimum of 3 rays from central N-pole to S-pole, with two below and 1 above, or similar, but must

   have at least 1 extra line below the wire than above.
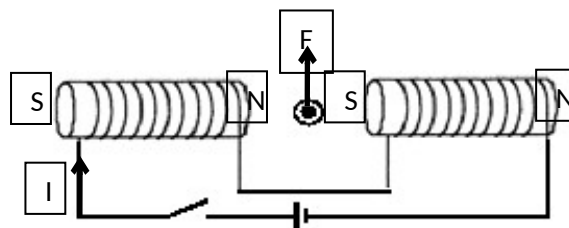


6a)
- Step down transformer  [1 mark]
- Turns ratio of 1000:1
- $I_S$ = 1000 $I_P$
- High $I^2r$ loss in the ring  [1 mark]
- Heating effect boils the water  [1 mark]

6b)  DC will not have a changing flux, so no induced emf or current in secondary coil.  [1 mark]

7. $5.33 \times 10^3$ A

8. approximately 1,833 times

9. $1.70 \times 10^6$ m/s

10. Some energy levels are:

 (spacing between lines must
  decrease as energy levels rise)

————————— 11.0 eV

————————— 7.9 eV

————————— 4.8 eV

————————— 0 eV
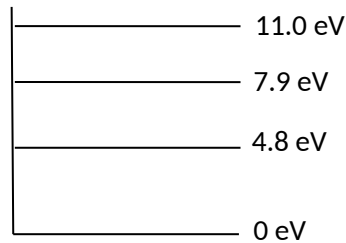
11. (2 marks explanation. 2 marks diagram)
 UV fluorescence.
 UV photon is absorbed, promoting electrons into higher energy levels. In fluorescent chemicals these promoted electrons then fall down in several stages, emitting photons of different wavelengths. These single wavelengths combine in the eye to give a perception of other colours.
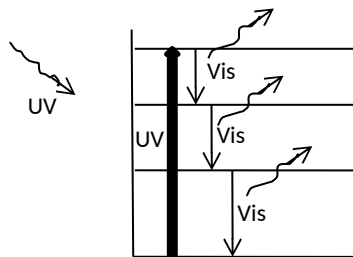


12. (1 mark each)
 • Spectra concerned are line absorption spectra.
 • Dark lines on an otherwise continuous spectrum.
 • Lines caused by atmosphere of the star absorbing those wavelengths it would emit if hot enough.
 • When spectrum of small star is viewed through the atmosphere of the large star, it will have extra dark lines due to the supergiant

13. 10.7 cm from the left hand end of the **rod.**

14a) $2.65 \times 10^{10}$ m/s

14b) Not possible [1 mark] with objects of mass to travel at or faster than 'c' [1 mark]

14c) $E = mc^2$

14d) Mass is a form of energy. As speed increases, so does an object's mass. Work done not only increases the speed, but also contributes to an increase in mass.

14e) $3.56 \times 10^{-27}$ kg

## Section 2

1. $T=\dfrac{2\pi r}{v}\wedge f=\dfrac{1}{T}\quad\therefore f=\dfrac{v}{2\pi r}\ldots\ldots(1)$

   And $F_C = F_B$ so $\dfrac{m v^2}{r} = qvB$

   So, $v=\dfrac{Bqr}{m}$, sub in equation (1)

   $(1) f =\dfrac{Bqr}{m}\div 2\pi r$

   $\therefore f =\dfrac{Bq}{2m}$

2. a) (i) DC motor has 1 split ring and AC has 2 slip rings.

   (ii) <u>DC:</u> Split ring reverses the direction of the current every $180^0$ rotation so that the coil
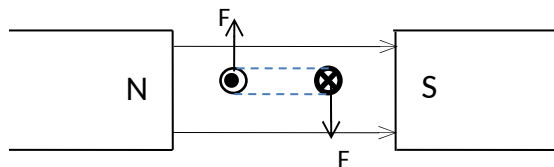   will continue to rotate in the same direction.

   <u>AC:</u> Needs no split ring as its current reversal occurs naturally as a consequence of the
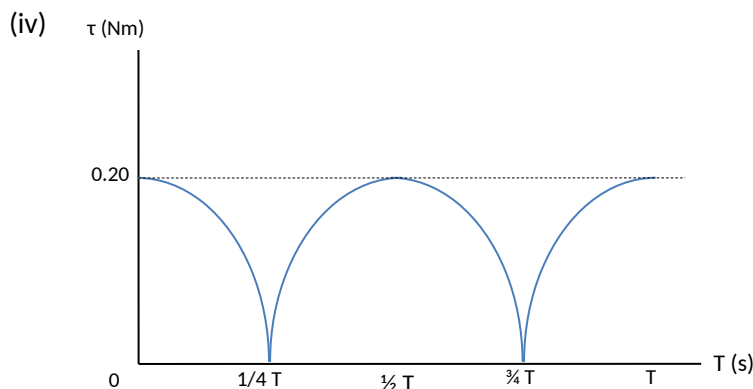
   AC current.

2b)
   - It would initially spin very fast due to the 50 Hz AC from the mains
   - The whole coil assembly would come to a standstill. It would then heat up and melt.

2c)     (i)                                                    (ii)    0.20 Nm                 (iii)    1.14 A



2c)
   (iv)    τ (Nm)



3.    (PART A)
      a)   20.2 m/s     b) (i)  zero  (ii)  9.8 m/s$^2$ down     c) (i) =   (ii) <  (iii)  >   d)  25.0 m/s

      (PART B)
      34.4 m/s at $48.6^0$ to the horizontal

4.  a) (i)  $3.34 \times 10^{18}$ m$^3$s$^{-2}$   (ii)  1 AU$^3$ y$^{-2}$   (iii)  $1.02 \times 10^{13}$ m$^3$s$^{-2}$

    b)  In a(i) and a(iii) the values of $k$ are different because of a different central body. This is also true for a(ii) and a(iii). Parts a(i) and a(ii) are different due to the different units, i.e. *'m'* and *'s'* rather than *'AU'* and *'year'*.

    c)  $8.12 \times 10^6$ m

    d)  (i)  $1.03 \times 10^{13}$ m/s$^2$          d) (ii)  $a_c = 3.16 \times 10^{11}$ m/s$^2$

d (iii)   The surface speed of a rotating body is greatest at the equator because the radius of rotation

is greatest  $v = \dfrac{2\pi r}{T}$ . At the equator the surface itself is accelerating down at the rate of  $\dfrac{v^2}{r}$  (this

is centripetal acceleration) in the same direction as *'g'*. This makes the <u>apparent</u> acceleration of

any body at the equator less. That is, at the equator,  $g_{app} = g - \dfrac{v^2}{r}$.

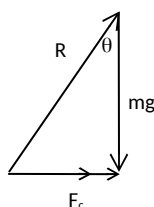5a)  $4.65 \times 10^4$ N          5b)  $5.02 \times 10^4$ N at $7.70^0$ above the ramp.

6a)
- AC generators are simpler, cheaper, more reliable and more efficient than DC gens. (1mk)
- AC voltages can easily be stepped up or down by transformers. (2 marks)
- Also the split rings in DC generators cause arcing which wastes energy and can be a safety concern. (1 mark)

6b)   $3.10 \times 10^5$ volt
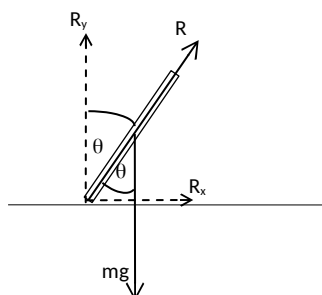
7a)                                                                          7b)   $3.10 \times 10^3$ N, radially inwards



7c)  (i)  167 km/h   (ii)  $74.7^0$

7d)
- Wet roads provide far less friction between the tyres and the road.
- Since friction provides the $F_c$ required, there is far less $F_c$ on a wet road.
- Since the radius of curvature and the total moving mass remain constant, the maximum speed on a wet road must be less.

7e)
- Banked roads have a component of the reaction force acting as the $F_c$ without depending on friction.
- Greater speeds possible since $F_c$ is produced by friction <u>PLUS</u> part of the reaction force.

## Section 3

1a)  distances in Mpc:   $8.28 \times 10^{-3}$  and   $7.79 \times 10^{-7}$

   Distances in ly:    $4.01 \times 10^{8}$  and   $4.89 \times 10^{8}$
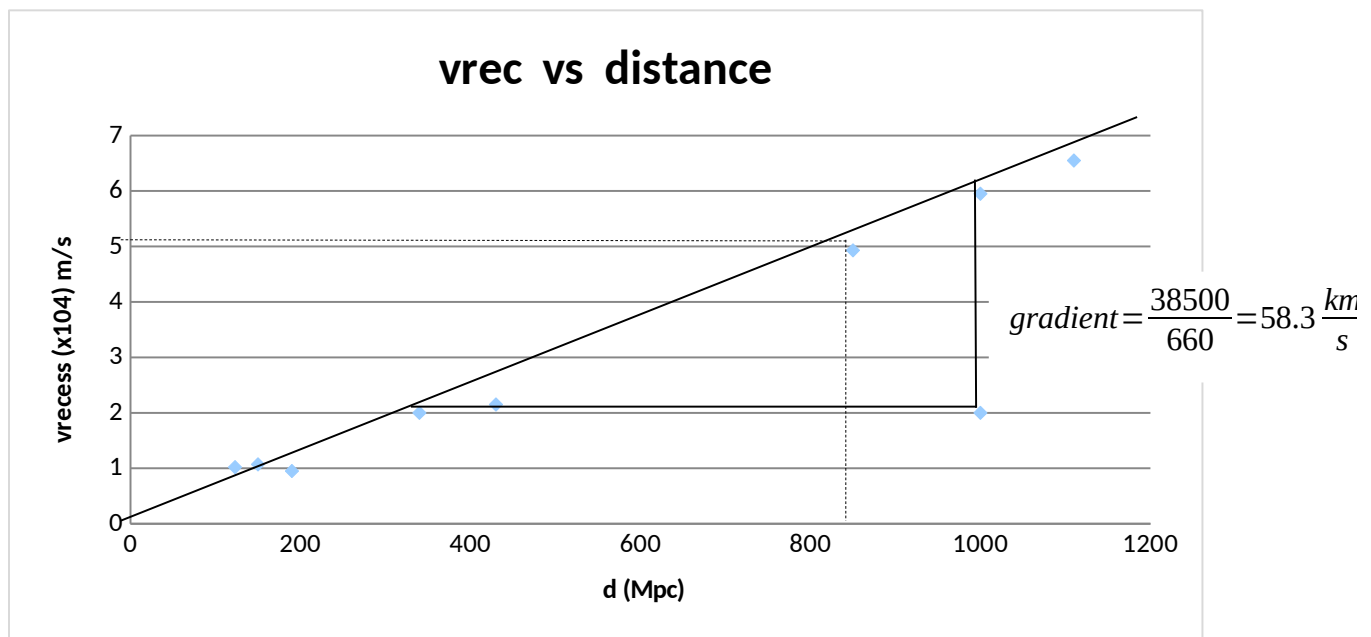
1b)  GRAPH

1c)  approx. 497 km/s  [must show on graph]

1d)   $H_0 = 58.3$ km.$\text{s}^{-1}$ per Mpc   [must show gradient triangle on graph]

1e)  Galaxies within the Local Group are moving as a unit through space. Within the Local Group galaxies move relative to each other. Andromeda galaxy is actually moving towards the Milky Way (our galaxy) at about 301 km/s. So Andromeda galaxy has a blueshift, not a redshift.

1f)   16.8 billion years

### vrec vs distance

$$gradient = \frac{38500}{660} = 58.3 \frac{km}{s}$$

(Graph: vrecess (x104) m/s versus d (Mpc))

2a)   Two distinctly different applications should be given (from within or outside of the text)

2b)   Phosphor coating glows under the effect of x-rays and thus exposes the film. The atoms are able to absorb X-ray frequency photons and retransmit them as visible frequencies. The visible frequencies react chemically with the film, leading to exposure.

2c)   Bone absorbs much of the X-rays and thus relatively little radiation passes through to cause the phosphor to glow and expose the film. The soft tissue allows passage of the X-rays and thus will "fog" the film.

2d)   The anode rotates so as to avoid the concentration of vast amounts of heat that is generated. This avoids damage.

2e)   Due to emissions of photons when electrons in atoms are excited by the bombardment of the target. The higher intensity (spike) the more probable/frequent the emission
OR   Spike occurs when electron is dislodged from deep within the electron cloud.

2f)   They remain in the same position since they are characteristic of the target. (Note that the intensity of the spike may be amplified).

2g)   The spikes appear in different positions, characteristic of the target metal.

2h)   Evacuated so that air molecules do not interfere with the electron beam that strikes the target.

      They are encased in lead so as to screen/protect the lab workers from the X-ray radiation.

2i)   $2.4 \times 10^{-14}$ Joule

2j)   $3.62 \times 10^{19}$ Hz.
      It has been assumed that there is a 100% energy transfer from the electron to the X-ray photon.

2k)   $8.33 \times 10^{-12}$ m