Resit Exam Questions for Module PX 144: "Introduction to Astronomy"

Useful physical constants:

Solar mass:	$M_\odot = 2 \times 10^{30}\,\mathrm{kg}$
Solar absolute magnitude:	$M_{abs,\odot} = 4.77\,\mathrm{mag}$
speed of light:	$c = 300000\,\mathrm{km\,s^{-1}}$
Gravitational constant:	$G = 6.67 \times 10^{-11}\,\mathrm{N\,m^2\,kg^{-2}}$
Hubble parameter:	$H_0 = 70\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$
Parsec:	$1\,\mathrm{pc} = 206265\,\mathrm{AU}$

Question 1 (Solar System):

a) (6 marks): With 3.3 years, Encke's comet has the shortest of all cometary periods.

i) What is the semi-major axis of the comet's orbit in units of AU {3}?
ii) The eccentricity of its orbit is $e = 0.847$. Compute its perihelion and aphelion distance {3}.

b) (6 marks): A planet is observed to move on a circular orbit around a star. The period of the orbit is 120 d and the radius of the orbit is measured to be 200 Million km. Estimate the mass of the star (give the mass in both, kg and solar units).

c) (13 marks): i) Explain why Mars is generally considered as the planet that is most similar to our Earth {7}.
ii) Extrasolar planets are normally found using spectroscopic methods and not by direct imaging. Describe the basis of these spectroscopic methods and list the major reasons why direct imaging is not as sensitive as spectroscopy {6}.

Question 2 (Stars):

a) (17 marks): Two stars are observed with their fluxes differing by a factor of 100. Both stars are known to be main sequence stars and have the same temperature. The brighter of these stars is known to have an apparent magnitude of $m = 5$ mag.

i) What is the magnitude of the fainter of these two stars {3}?
ii) The fainter star has a distance of 100 pc, what is the distance of the brighter star{3}?
iii) Compute the stars absolute magnitude {3}
iv) Draw a clearly labeled Hertzsprung-Russell Diagram, identifying the location of the Sun and of the Main Sequence {6}
v) Given the absolute magnitude of the stars, what do you think is their spectral type{2}?

b) (8 marks): The mass-luminosity relationship is $L \propto M^4$, where the luminosity L and the mass M are both measured in solar units.

i) The total time the Sun spends on the Main Sequence is 10^10 years. Estimate the time a star with a mass of 30 $M_\odot$ lives on the main sequence {3}!
ii) Stars with 30 $M_\odot$ end their life in a supernova, leaving a black hole. Describe the main properties of black holes, including one way on how black holes can be detected {5}.

Question 3 (Galaxies):

a) (10 marks) Supernovae of type Ia have absolute magnitudes of $M = -18.33$ mag at the maximum of their outburst. A supernova is observed in a spiral galaxy to have the magnitude $m = 15$ mag at the peak of its outburst.

i) Compute the distance module and the distance to the galaxy {3}.
ii) Using Hubble's law, compute the recession velocity of the galaxy {2}.
iii) Spiral galaxies have radii of 10 kpc. Compute the angular diameter of the galaxy. Assuming Earth bound telescopes are limited to an angular resolution of $0.1''$, would you be able to determine its angular diameter? {5}

b) (5 marks) Galaxies come in different types, first classified by Edwin Hubble. Draw the "Hubble tuning fork diagram" and briefly describe the properties of elliptical galaxies.

c) (10 marks) One of the fundamental claims of modern cosmology is that the universe is homogeneous and isotropic, that is, the properties of the universe today do not depend on where they are measured and the properties are independent on the direction of the observation. Describe how you would observationally test this assumption.